Producer-Oriented Tillage Project, Crop Year 2002

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Demonstration Description

Tillage represents one of the critical components in a farming system and producers view tillage as a necessary process to prepare a seedbed, incorporate nutrients and pesticides, or control weeds. Reduction in tillage reduces erosion because of greater protection of the soil surface from the effects of wind and water; however, producers often view reduced tillage as increasing risk in crop yield due to pests, nutrient availability, or compaction. This study was designed to compare four tillage systems in both corn and soybean production on producer fields across Iowa to demonstrate that reduced tillage would not increase risk in crop yield. The four tillage systems selected in consultation with the cooperating producers were; fall-chisel (FT), fall-strip (FS), spring tillage (ST), and spring strip tillage at planting (SS). Both corn and soybean were planted on the tillage systems within the same field in order to provide a direct comparison of the rotation effect of the crops under the same tillage system within the same year.

The objectives of this study are to:

1. Quantify the effect of four tillage practices on changes in soil properties.
2. Quantify the effect of four tillage practices on crop performance and economic return.
3. Quantify the response of local producers in each region to the study results.
4. Evaluate the potential behavioral change in producers in each region in terms of changing tillage practices that will increase profit and improve environmental quality.

In consultation with the cooperating producers, there were a series of additional questions. These included the effect of tillage on the soil, interactions of tillage systems with corn hybrid and soybean cultivar performance, and a detailed documentation of the effect of fall-strip and spring-strip tillage on changes in soil temperature and soil water in the seed zone. These studies are being conducted at Ames on a research site that has the same plot layout as the demonstration sites in an effort to provide answers for potential questions about differences among demonstration sites.

This project commenced with the 2002 cropping season, which represents the establishment year for most of the tillage plots. Prior to planting, a series of soil samples were collected at each site to document initial nutrient and organic matter distribution within the soil profile. Samples will be collected each fall after harvest to quantify the changes in the soil profile. The sample locations are recorded with a GPS unit to determine the location within the study area.

Agreements were made with local FFA chapters at each demonstration site to collect crop growth data throughout the year and assist with site management. Observations at each site included plant emergence, density, and height, crop residue cover and mass, and general observations. Crop yield was determined by hand-harvest within plots at maturity along with combine yields (yield monitor and/or weigh-wagon) from each plot strip. Each producer collected data on the labor requirements for different systems and the production costs of each tillage system in order to develop an economic comparison of the different systems. Each site has a meteorological station located adjacent to the field to record air and soil temperatures, solar radiation, wind speed and direction, and precipitation. Soil temperatures at several depths to 50 in. within all of the tillage systems were measured at Algona and Ames.

The goal of this demonstration project is to show the differences among systems on crop performance (growth, vigor, and yield), the economic return, and the potential effects on environmental quality. Environmental quality data will be determined both directly and indirectly. The direct measurements will be made using a rainfall simulator on selected sites

after planting in 2003 to quantify the effect of these tillage systems on erosion rates. Indirect measurements of environmental quality impacts will be made from a comparison of the nitrogen applied and removed through grain yield in the different tillage systems. The leaf chlorophyll measurements provide a measure of nitrogen sufficiency during the growing season. This measurement provides a direct indication that nitrogen is adequate for crop growth during the season. Data being collected on the nitrogen status will help producers be able to assess that reduced amounts of N with different tillage systems will not lead to yield reductions.

The expectations of this project are to show that reduced tillage can lead to improved crop production efficiency because there is a reduction in inputs, e.g., labor, nutrients, and equipment costs, while maintaining or increasing crop yields and reducing potential environment impacts. The linkage of the demonstration sites with an intense research site helps producers understand the reasons for the variation among treatments and provide a greater database to facilitate adoption across the state.

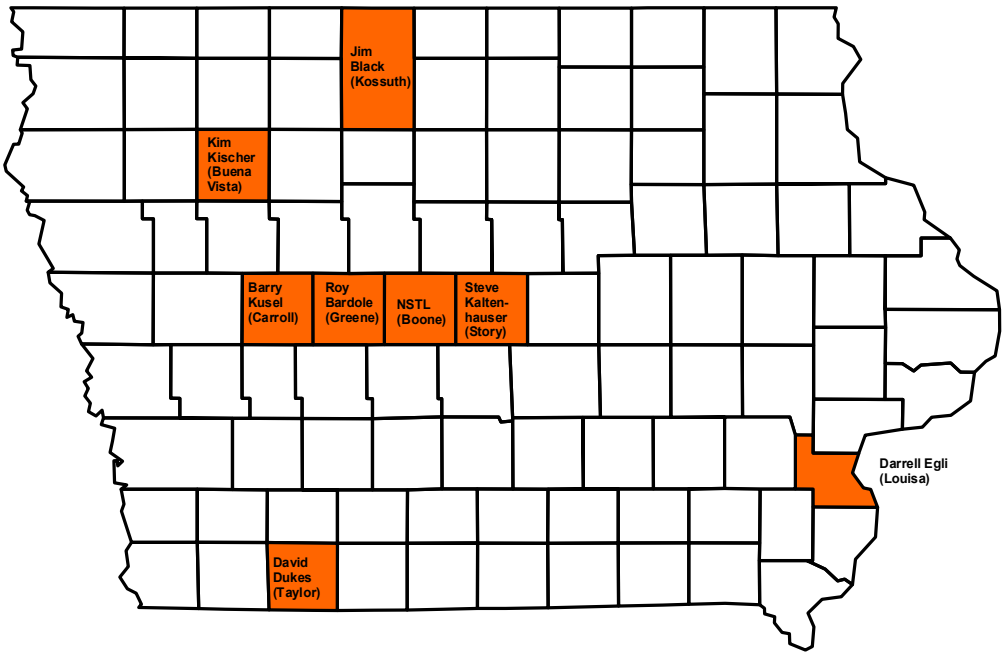
Table 1. Timetable for the tillage demonstration project.

Project Task	Year 1-2002				Year 2-2003				Year 3-2004				
	1	2	3	4	1	2	3	4	1	2	3	4	1
Identify sites	C												
Conduct soil analyses	C												
Implement tillage practices	C		C		X		X		X		X		
Install monitoring equipment	C	C											
Develop protocols and train observers		C	C										
Implement agronomic practices			C				X				X		
Conduct soil sampling in plots			C	C			X	X			X	X	
Field days				C				X				X	
Website development		C	C										
Populate website			C	C	X	X	X	X	X	X	X	X	X
Prepare outreach material			C	C									
Record and archive data		C	C	I	X	X	X	X	X	X	X	X	X
Conduct annual reviews with cooperators					X				X				X
Conduct surveys on project				I				X				X	
Educational outreach to consultants, agronomists, NRCS			C			X				X			X
Prepare reports				C				X					X
Distribute material to Media			C			X	X			X	X	X	

C-Completed task, I-In progress, X-Planned task

Demonstration Sites and Locations

1. Roy Bardole, Rippey, Greene County
2. Jim Black, Algona, Kossuth County
3. David Dukes, Bedford, Taylor County
4. Darrell Egli, Columbus Junction, Louisa County
5. Steve Kaltenheuser, Kelly, Story County
6. Kim Kischer, Albert City, Buena Vista County
7. Barry Kusel, Manning, Carroll County
8. NSTL, Ames, Boone County



Map of Demonstration Sites in Iowa

Results - by Site

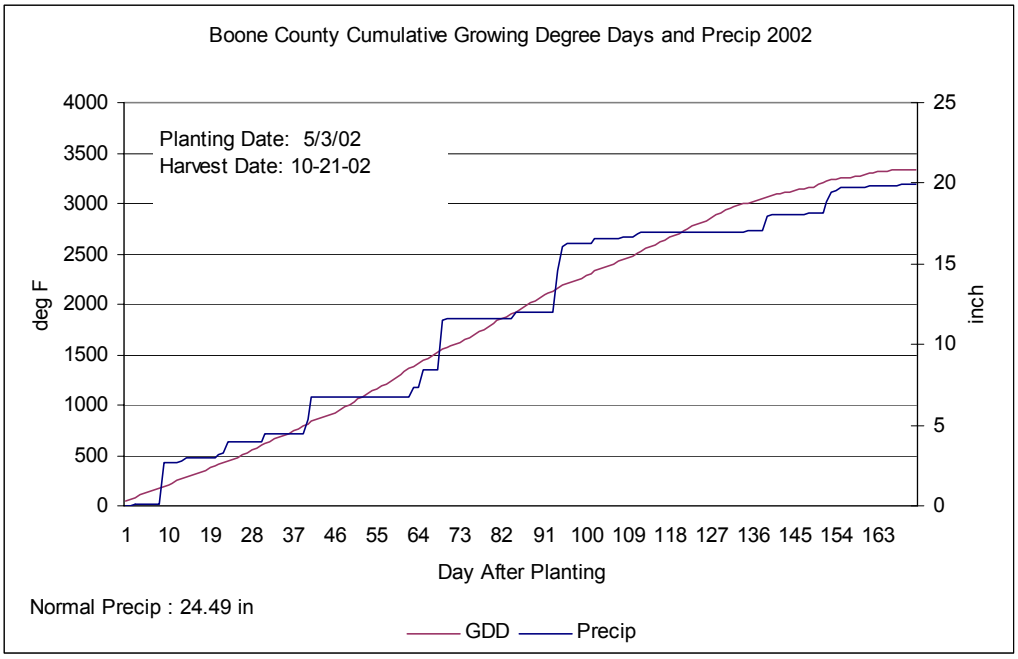
Maps of the plot areas overlain on soil maps are shown below for each of the demonstration sites. Also included for each site are graphs of growing degree days (GDD) and precipitation, corn yield and quality, soybean yield and quality, and crop residue mass following harvest for both corn and soybean. Statistical analyses have yet to be completed on these data. Note that FT = fall till, FS = fall strip, ST = spring till, and SS = spring strip.

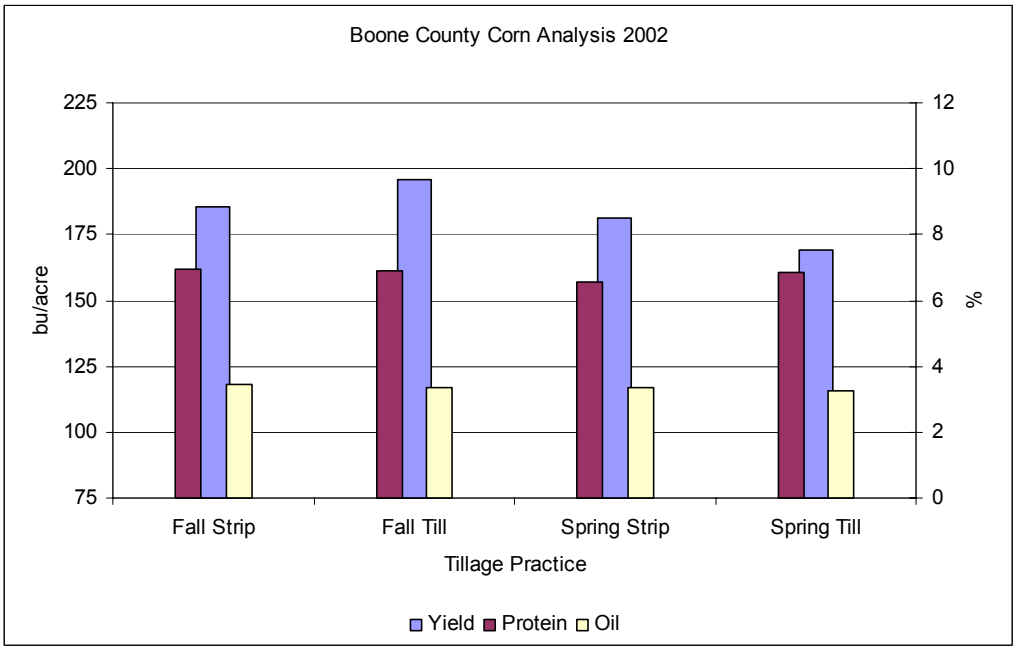
Boone County
ISU Kelly Farm

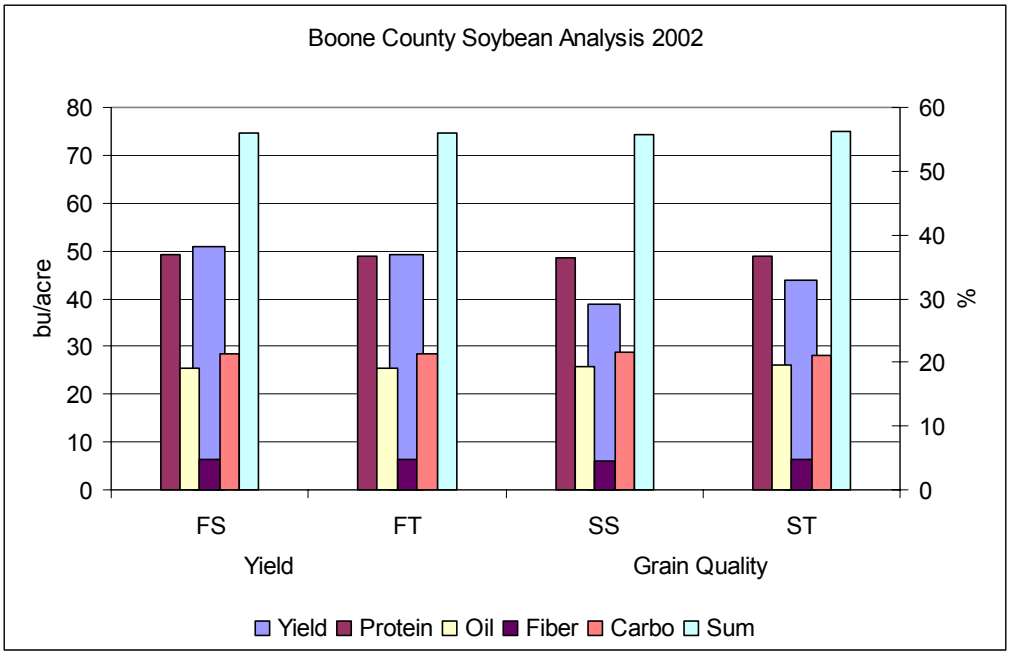
Soil Boundary
Outer Field Boundary
Field Boundary (Preliminary)
Drainages

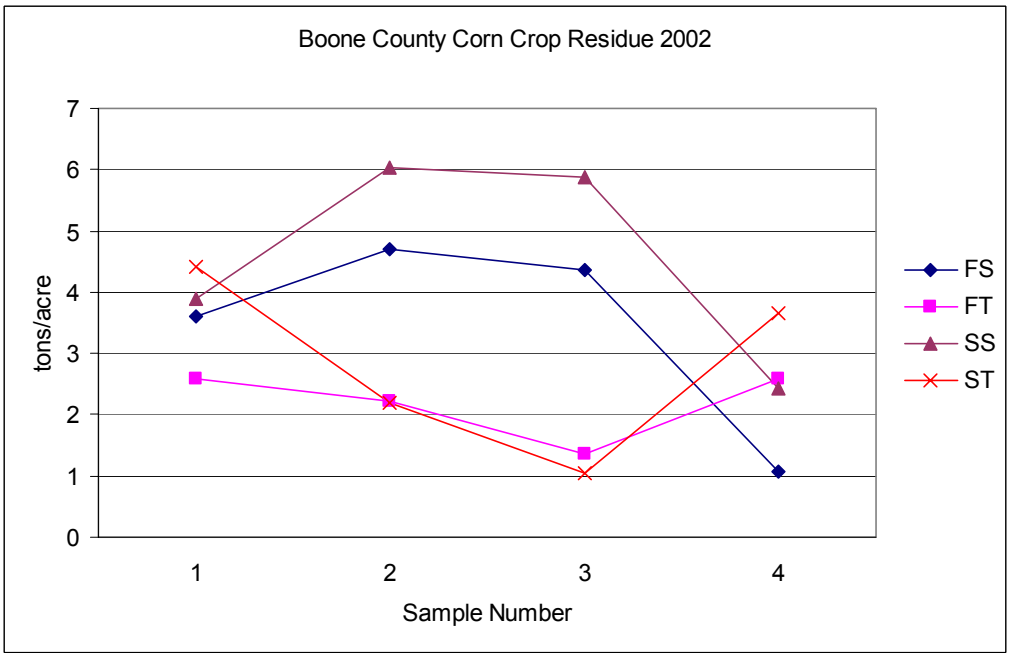
55: Nicollet loam
62D2: Storden loam
138B: Clarion loam, 2-5% slopes
138C: Clarion loam, 5-9% slopes
138C2: Clarion loam, 5-9% slopes, moderately eroded
507: Canisteo clay loam

Scale 1:2997


Boone County Cumulative Growing Degree Days and Precip 2002
Planting Date: 5/3/02
Harvest Date: 10-21-02
deg F
inch
4000
3500
3000
2500
2000
1500
1000
500
0
25
20
15
10
5
0
1 10 19 28 37 46 55 64 73 82 91 100 109 118 127 136 145 154 163
Day After Planting
Normal Precip : 24.49 in
GDD
Precip


Boone County Corn Analysis 2002
bu/acre
%
225
200
175
150
125
100
75
12
10
8
6
4
2
0
Fall Strip
Fall Till
Spring Strip
Spring Till
Tillage Practice
Yield
Protein
Oil


Boone County Soybean Analysis 2002
bu/acre
%
80
70
60
50
40
30
20
10
0
60
50
40
30
20
10
0
FS
FT
SS
ST
Yield
Grain Quality
Yield
Protein
Oil
Fiber
Carbo
Sum


Boone County Corn Crop Residue 2002
tons/acre
7
6
5
4
3
2
1
0
1
2
3
4
Sample Number
FS
FT
SS
ST

IFLM Project
2002

Soil Boundary
Field Border
Plot Boundary
Drainages

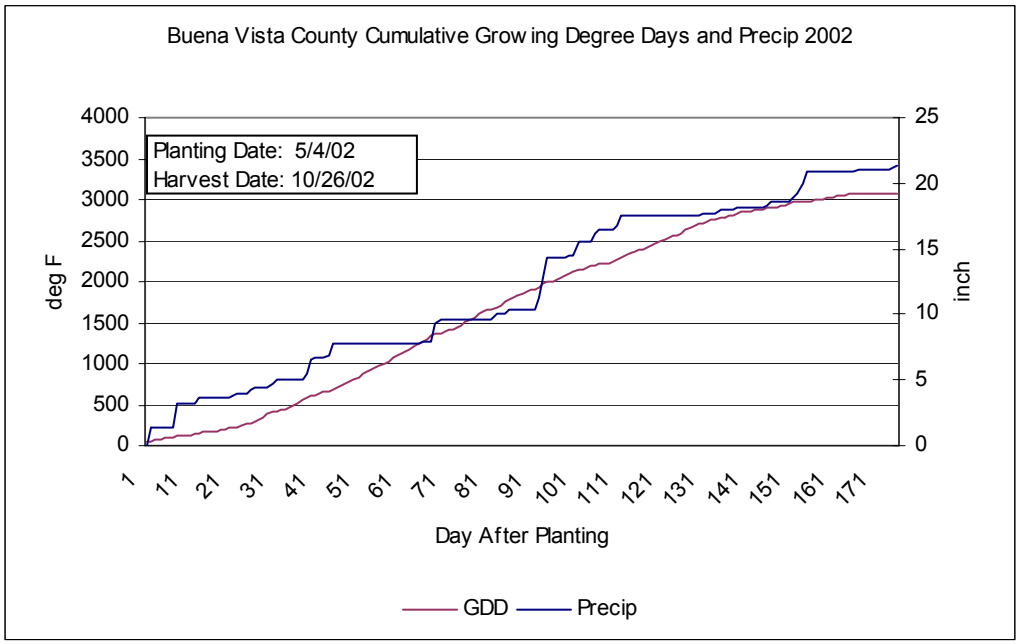
Buena Vista County: Kischer Farm
T92N R35W Section 9
UTM, Zone 15, meters, NAD83

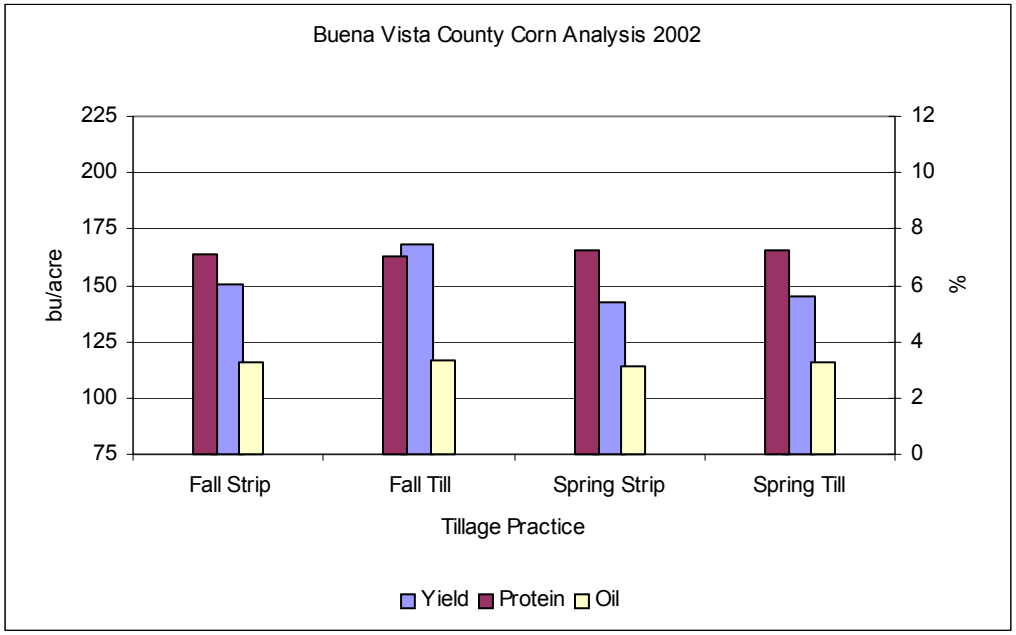
Scale 1:3960

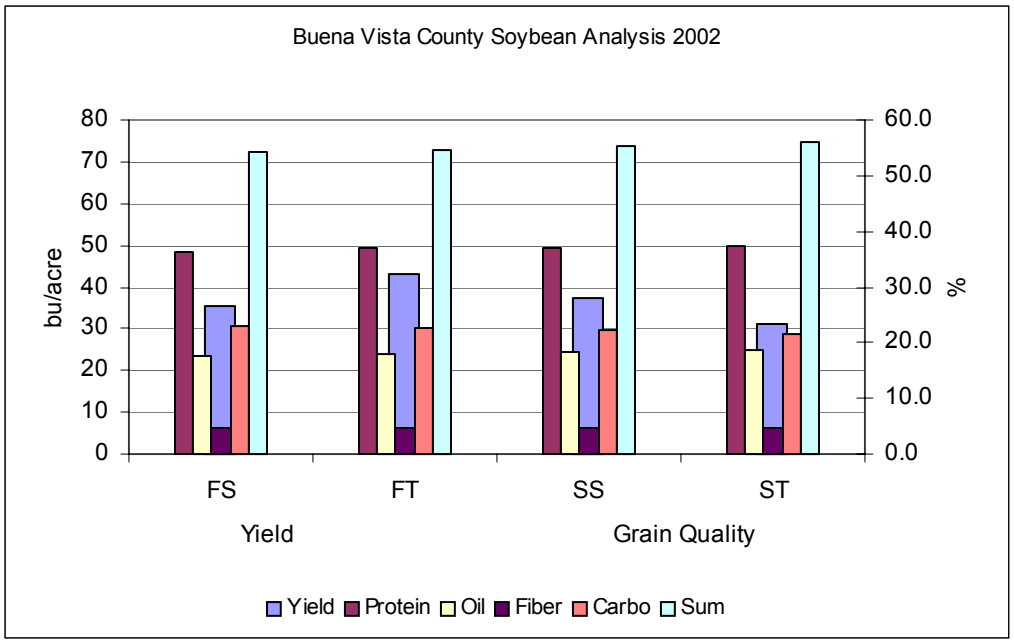
Prepared By: Wolfgang Oesterreich
USDA-ARS
National Soil Tilth Lab
Ames, IA

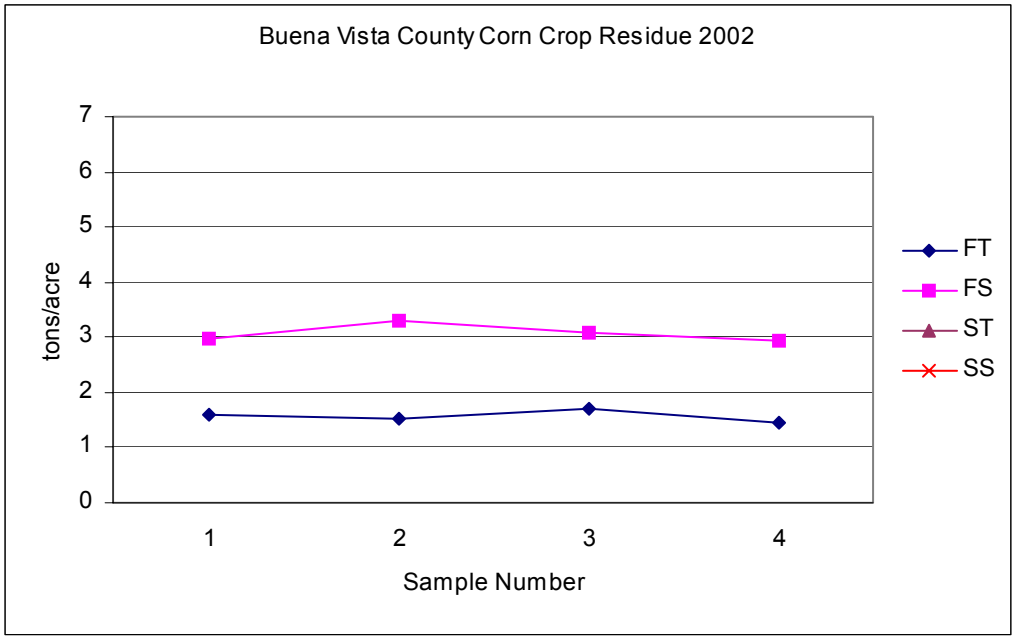
55: Nicollet loam
138B: Clarion loam
507: Canisteo clay loam

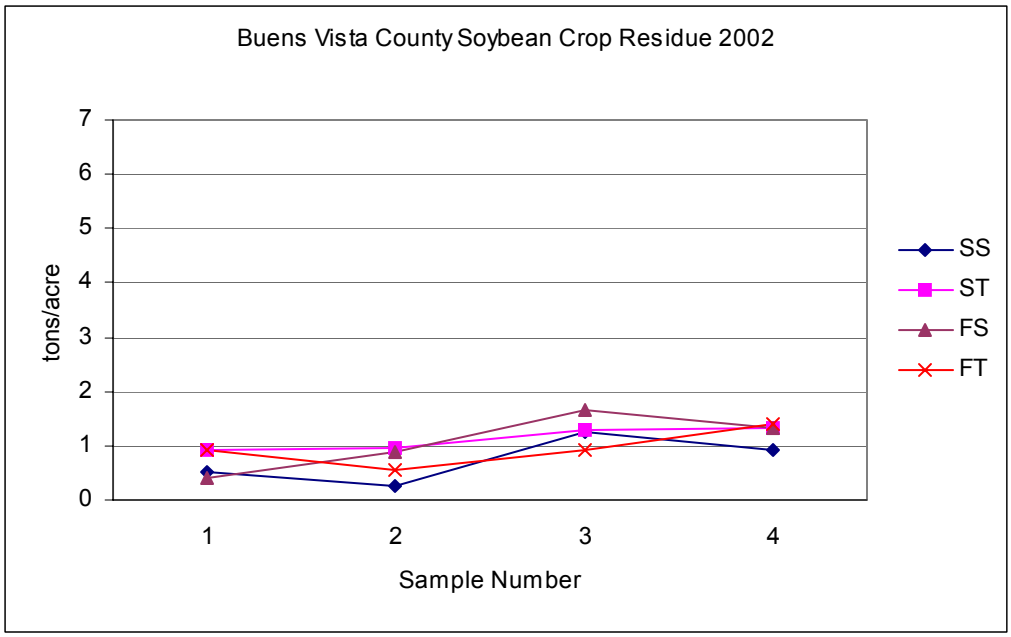
12 Feb 02


Buena Vista County Cumulative Growing Degree Days and Precip 2002
Planting Date: 5/4/02
Harvest Date: 10/26/02
deg F
inch
4000
3500
3000
2500
2000
1500
1000
500
0
25
20
15
10
5
0
1
11
21
31
41
51
61
71
81
91
101
111
121
131
141
151
161
171
Day After Planting
GDD
Precip


Buena Vista County Corn Analysis 2002
bu/acre
%
225
200
175
150
125
100
75
12
10
8
6
4
2
0
Fall Strip
Fall Till
Spring Strip
Spring Till
Tillage Practice
Yield
Protein
Oil


Buena Vista County Soybean Analysis 2002
bu/acre
%
80
70
60
50
40
30
20
10
0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
FS
FT
SS
ST
Yield
Grain Quality
Yield
Protein
Oil
Fiber
Carbo
Sum


Buena Vista County Corn Crop Residue 2002
tons/acre
7
6
5
4
3
2
1
0
1
2
3
4
Sample Number
FT
FS
ST
SS


Buens Vista County Soybean Crop Residue 2002
tons/acre
7
6
5
4
3
2
1
0
1
2
3
4
Sample Number
SS
ST
FS
FT

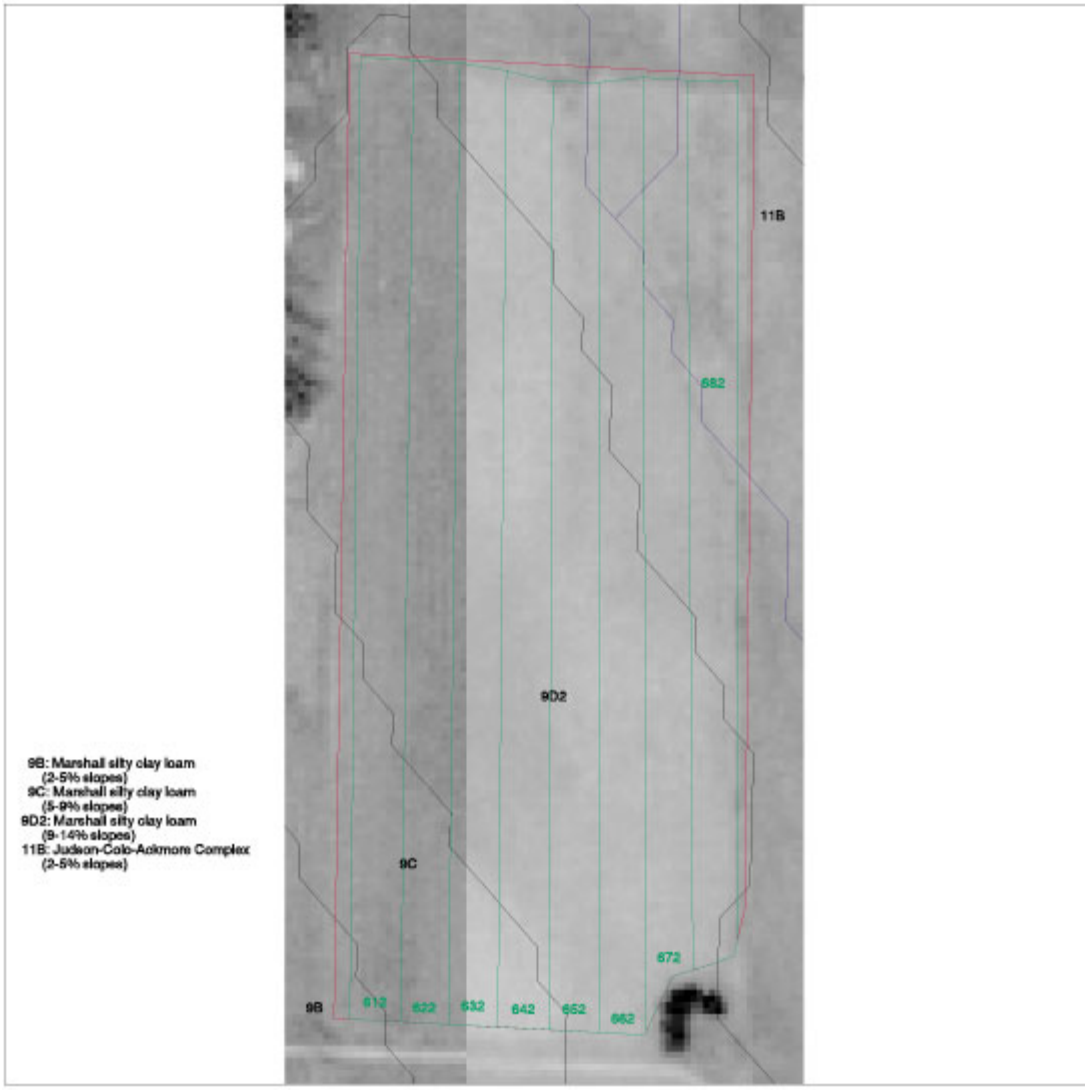
IFLM Project
2002

Soil Boundary
Field Border
Plot Boundary (preliminary)
Drainages

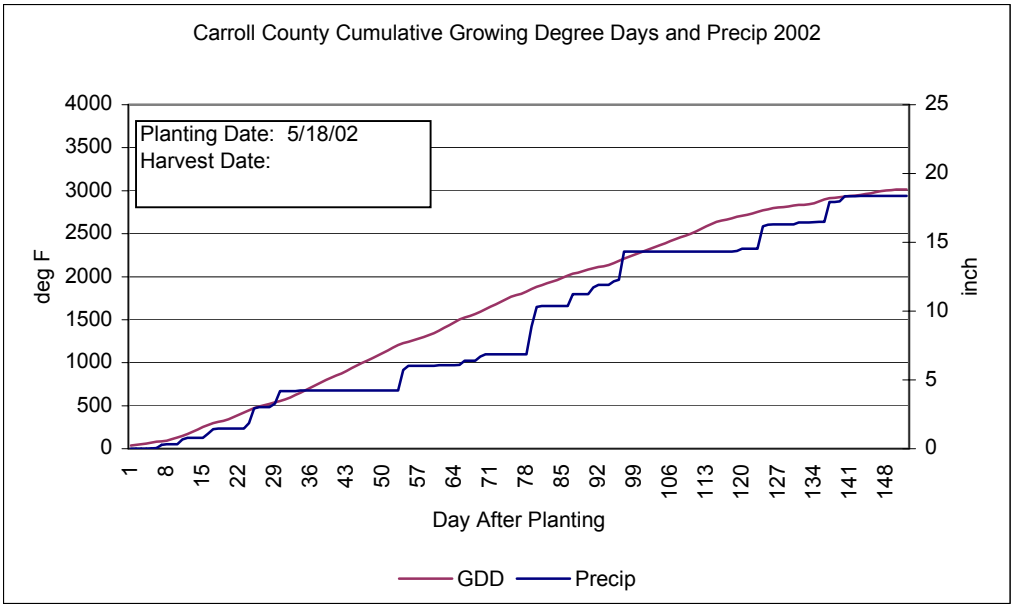
Carroll County: Kusel Farm
T82N R36W Section 20
UTM, Zone 15, meters, NAD83

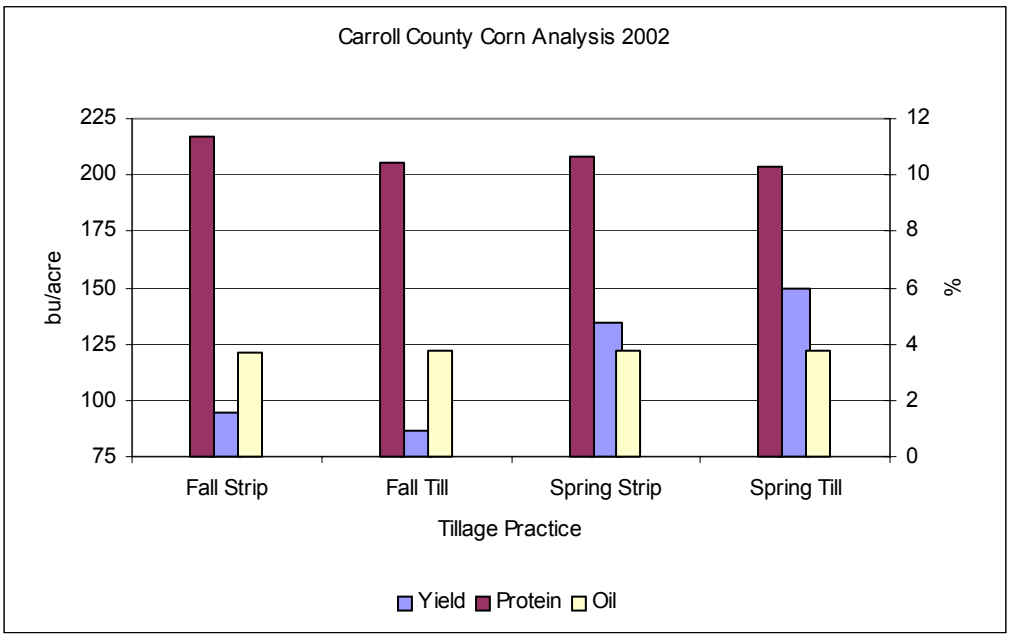
Scale 1:1823

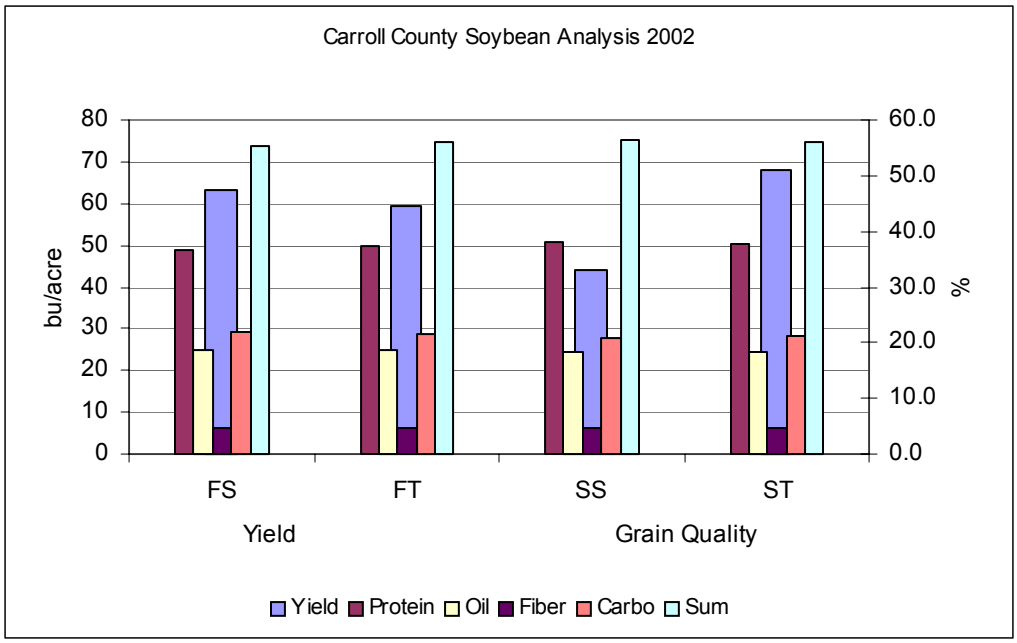
Prepared By: Wolfgang Oesterreich
USDA-ARS
National Soil Tilth Lab
Ames, IA



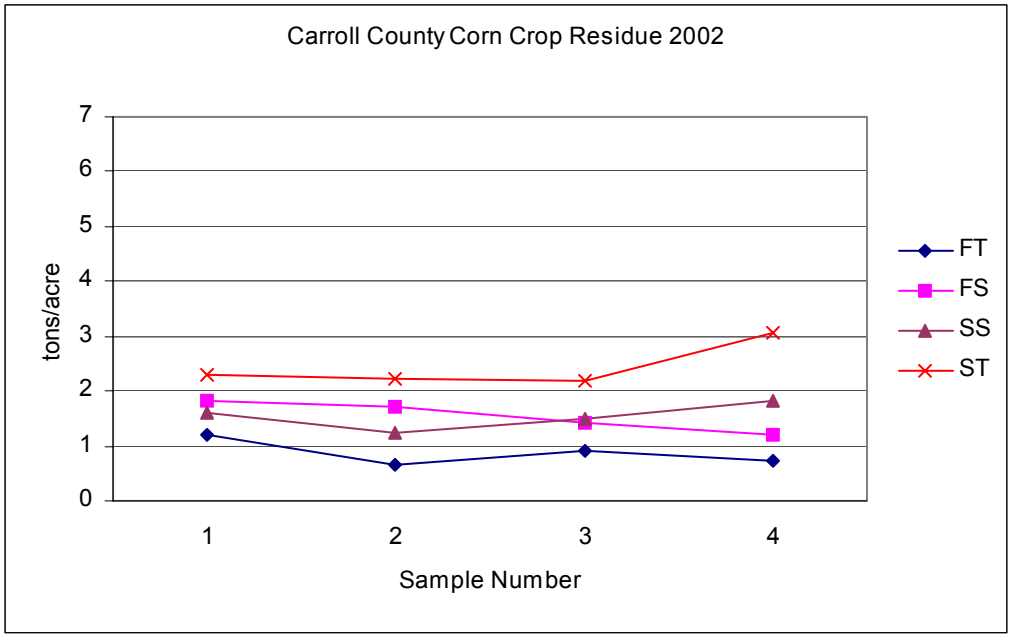
14 Feb 02

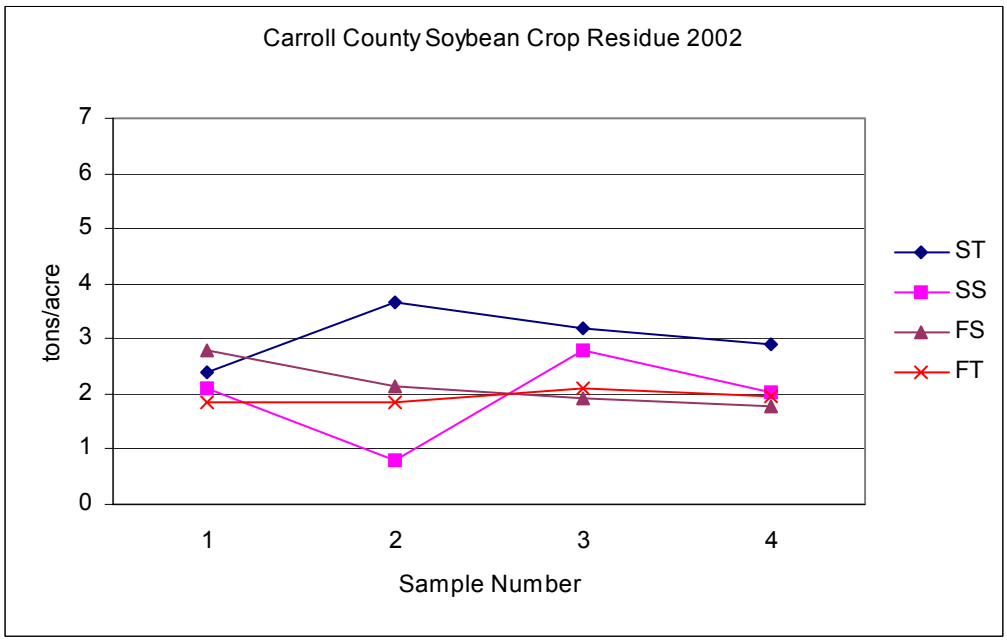

Carroll County Cumulative Growing Degree Days and Precip 2002
Planting Date: 5/18/02
Harvest Date:
deg F
inch
Day After Planting
GDD
Precip


Carroll County Corn Analysis 2002
bu/acre
%
Fall Strip
Fall Till
Spring Strip
Spring Till
Tillage Practice
Yield
Protein
Oil



Photograph of the Manning site in Carroll County on July 11, 2002. There is no noticeable difference among tillage systems.


Carroll County Corn Crop Residue 2002
tons/acre
0
1
2
3
4
5
6
7
1
2
3
4
Sample Number
FT
FS
SS
ST


Carroll County Soybean Crop Residue 2002
tons/acre
0
1
2
3
4
5
6
7
1
2
3
4
Sample Number
ST
SS
FS
FT

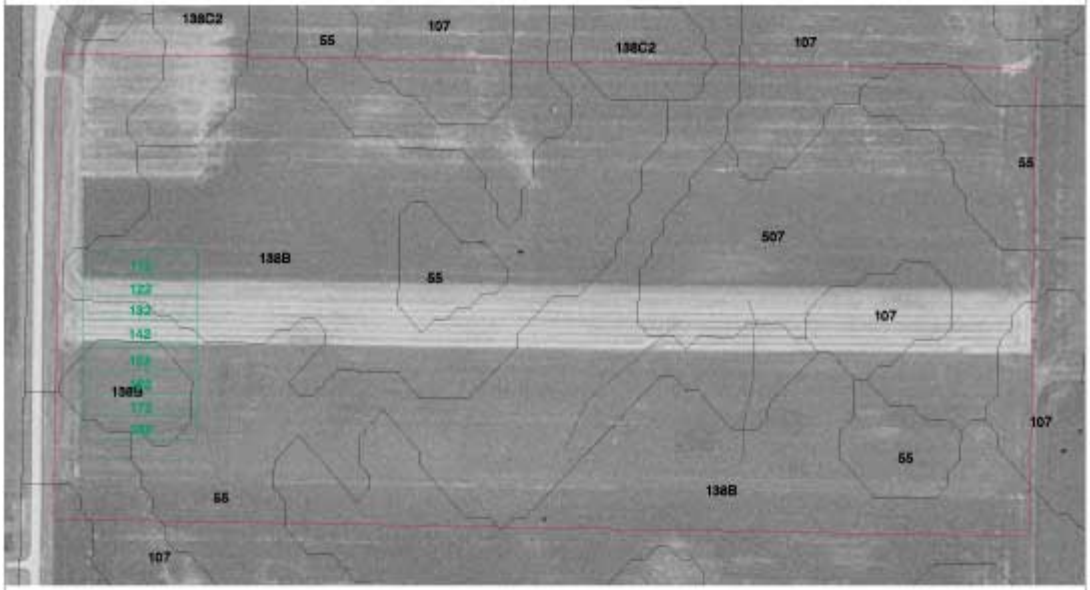
IFLM Project
2002

Soil Boundary
Field Border
Plot Boundary
Drainages

Greene County: Bardole Farm
T82N R29W Section 9
UTM, Zone 15, meters, NAD83

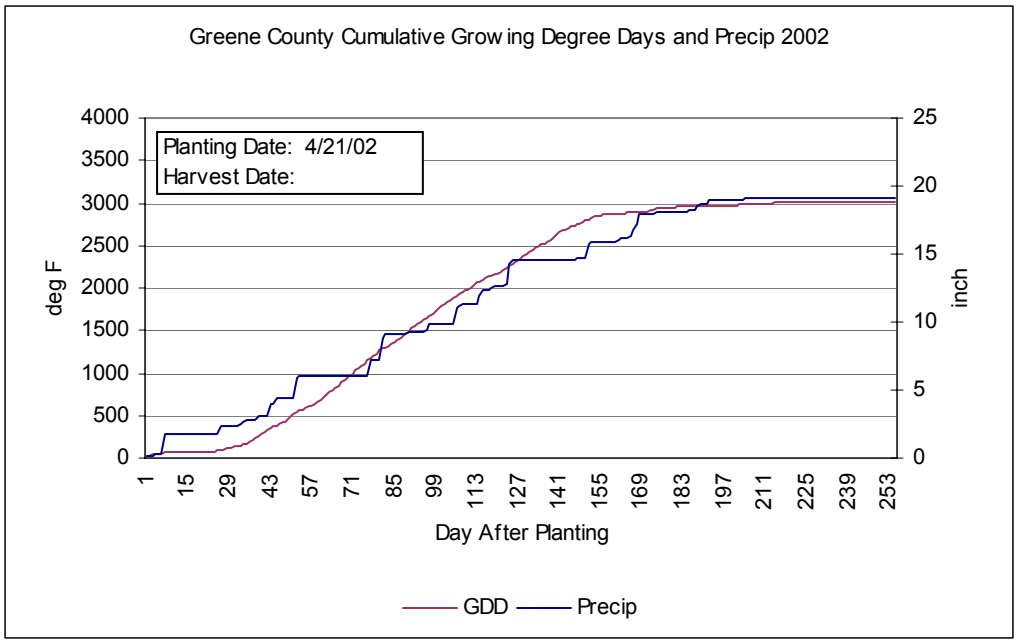
Scale 1:4571

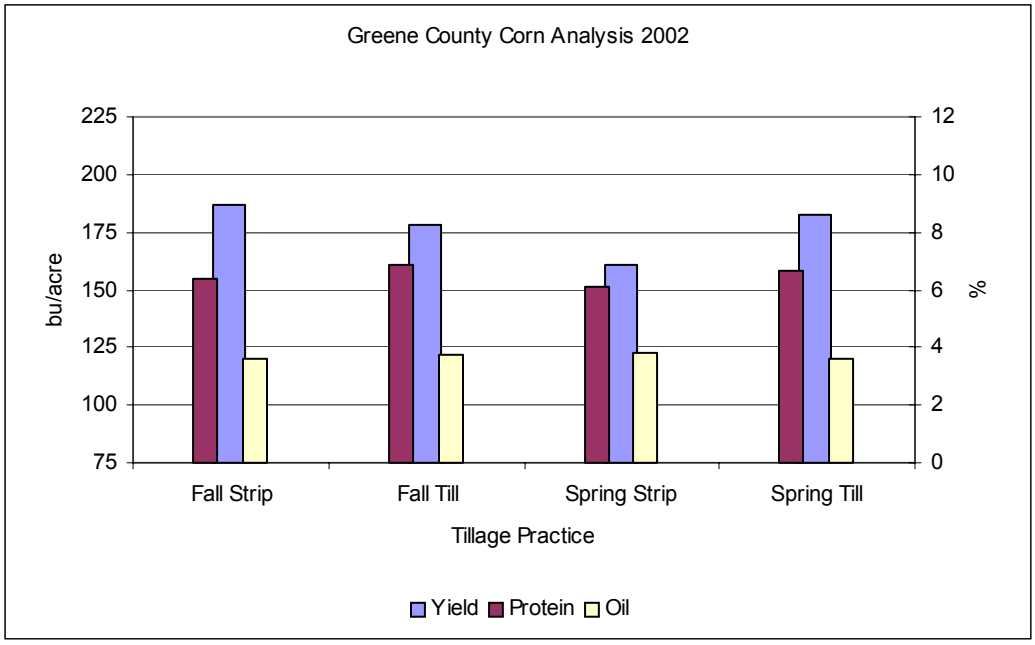
Prepared By: Wolfgang Oesterreich
USDA-ARS
National Soil Tilth Lab
Ames, IA

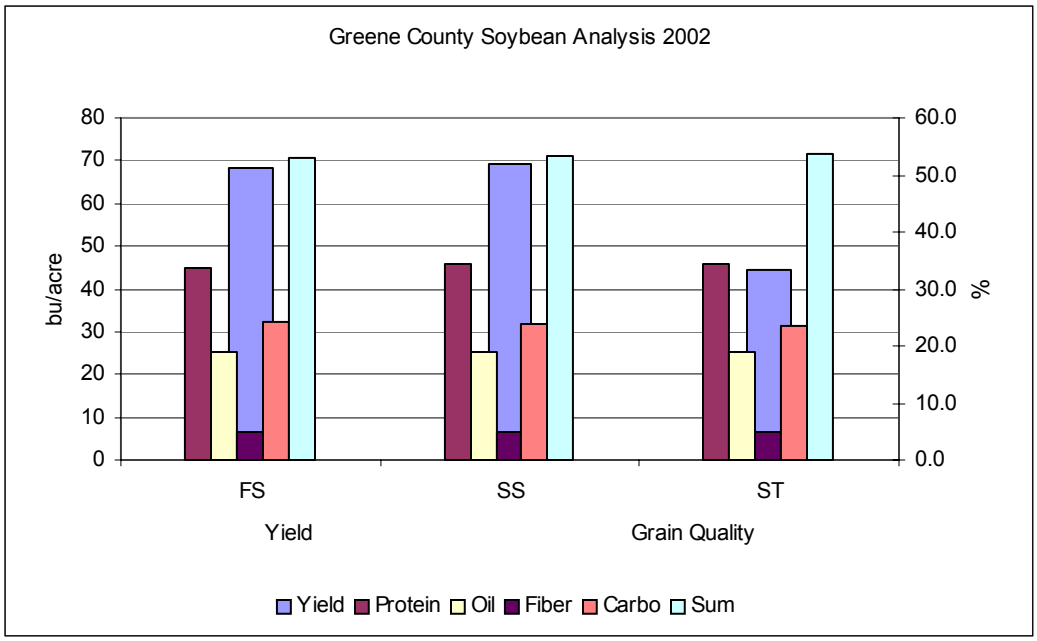


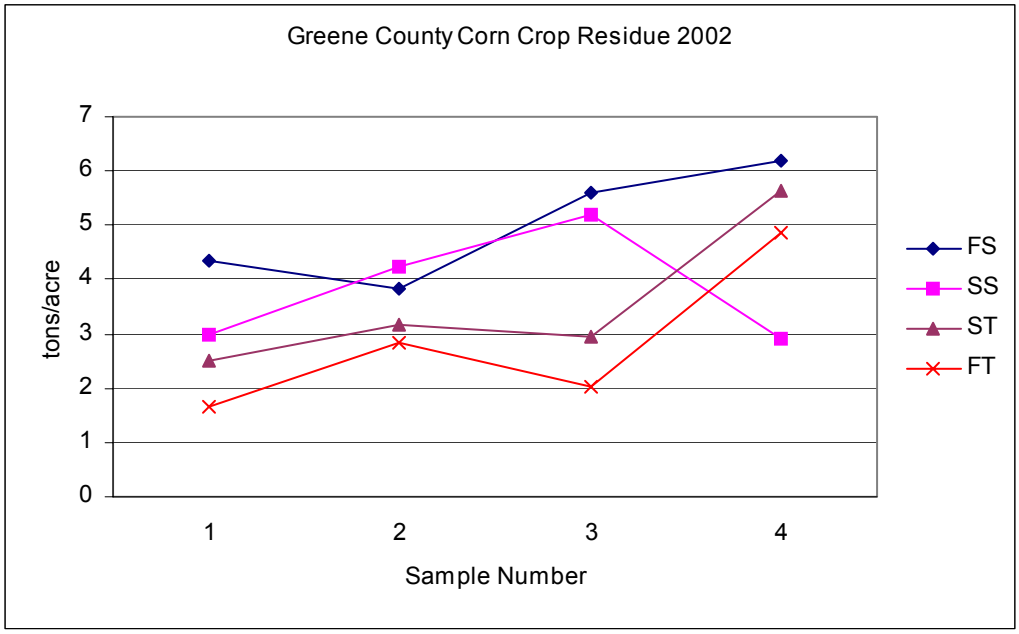
55: Nicollet loam
107: Webster clay loam
138B: Clarion loam, 2-5% slope
138C2: Clarion loam, 5-9% slope, moderately eroded
507: Canisteo clay loam

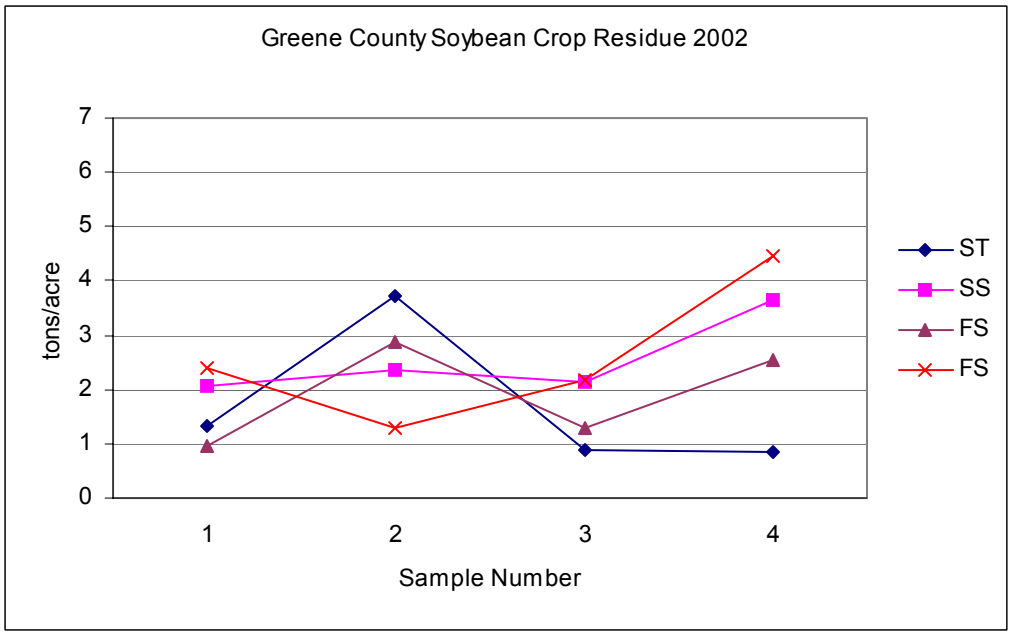
14 Feb 02


Greene County Cumulative Growing Degree Days and Precip 2002
Planting Date: 4/21/02
Harvest Date:
deg F
inch
4000
3500
3000
2500
2000
1500
1000
500
0
25
20
15
10
5
0
1
15
29
43
57
71
85
99
113
127
141
155
169
183
197
211
225
239
253
Day After Planting
GDD
Precip


Greene County Corn Analysis 2002
bu/acre
%
225
200
175
150
125
100
75
12
10
8
6
4
2
0
Fall Strip
Fall Till
Spring Strip
Spring Till
Tillage Practice
Yield
Protein
Oil


Greene County Soybean Analysis 2002
bu/acre
%
80
70
60
50
40
30
20
10
0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
FS
SS
ST
Yield
Grain Quality
Yield
Protein
Oil
Fiber
Carbo
Sum


Greene County Corn Crop Residue 2002
tons/acre
7
6
5
4
3
2
1
0
1
2
3
4
Sample Number
FS
SS
ST
FT


Greene County Soybean Crop Residue 2002
tons/acre
0
1
2
3
4
5
6
7
1
2
3
4
Sample Number
ST
SS
FS
FS

IFLM Project
2002

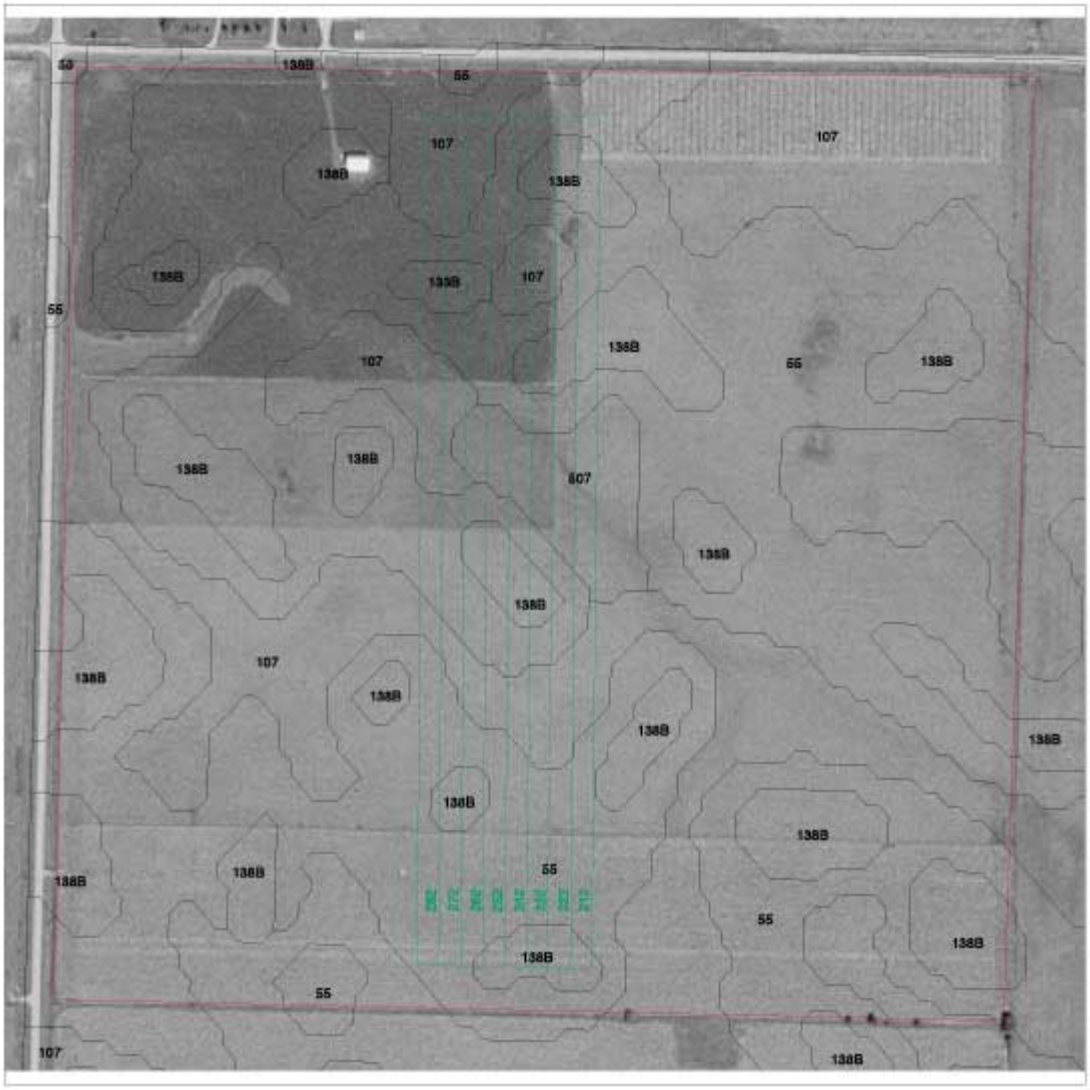
Soil Boundary
Field Border
Plot Boundary
Drainages

Kossuth County: Black Farm
T95N R28W Section 15
UTM, Zone 15, meters, NAD83

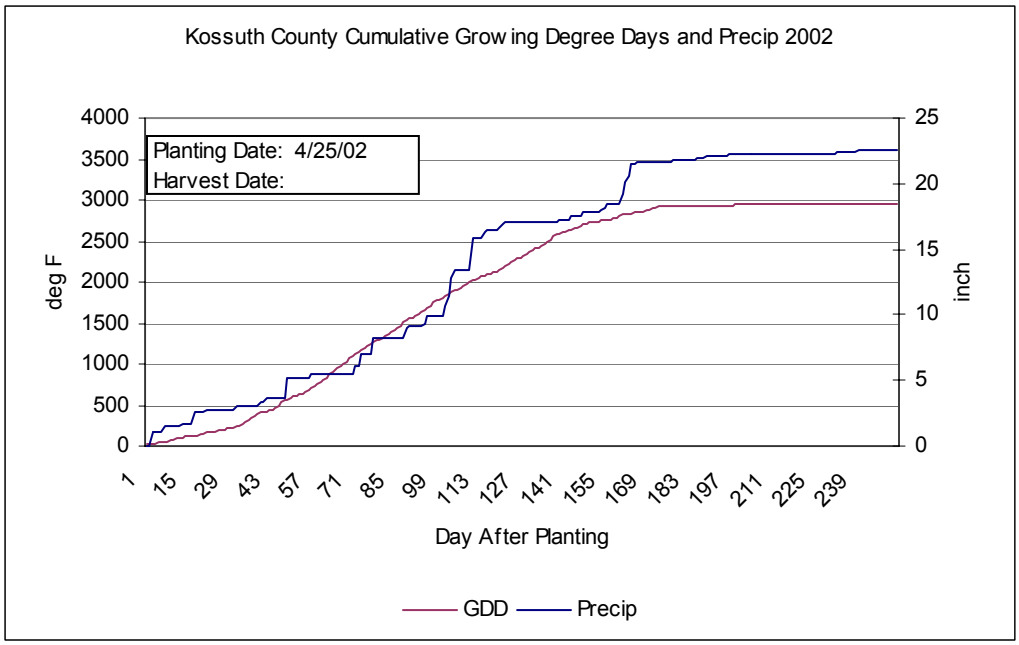
Scale 1:4659

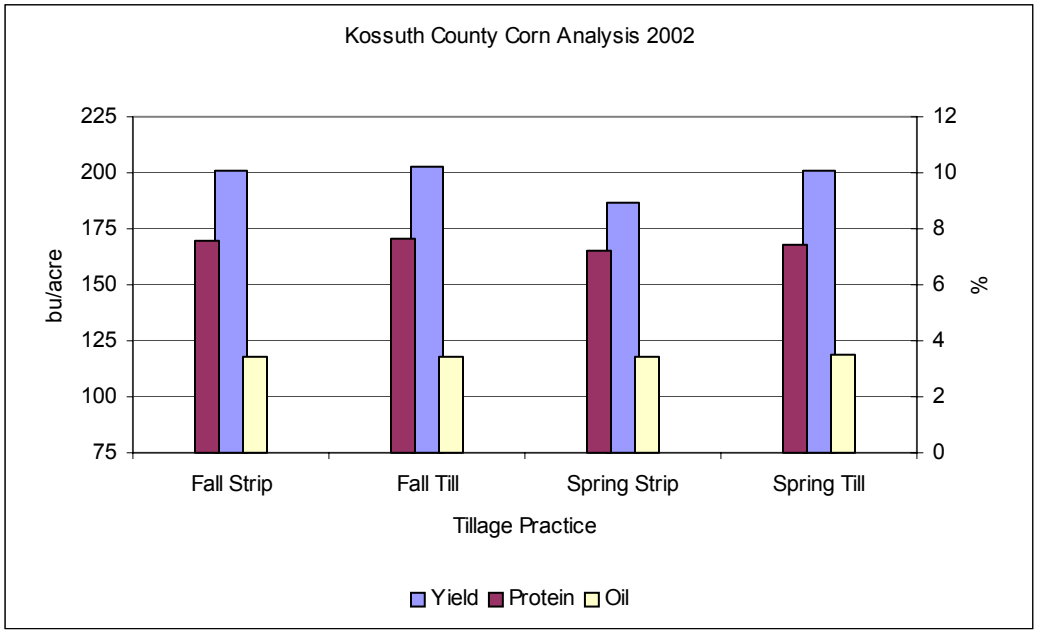
55: Nicollet loam
107: Webster clay loam
133B: Colo silty clay loam
138B: Clarion loam
507: Canisteo clay loam

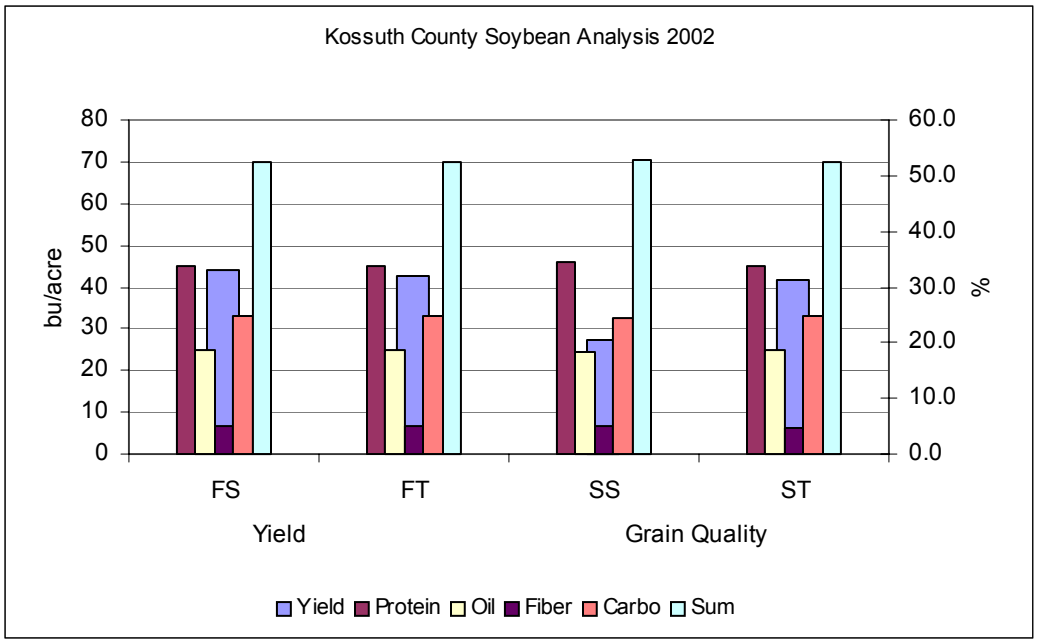
Prepared By: Wolfgang Oesterreich
USDA-ARS
National Soil Tilth Lab
Ames, IA

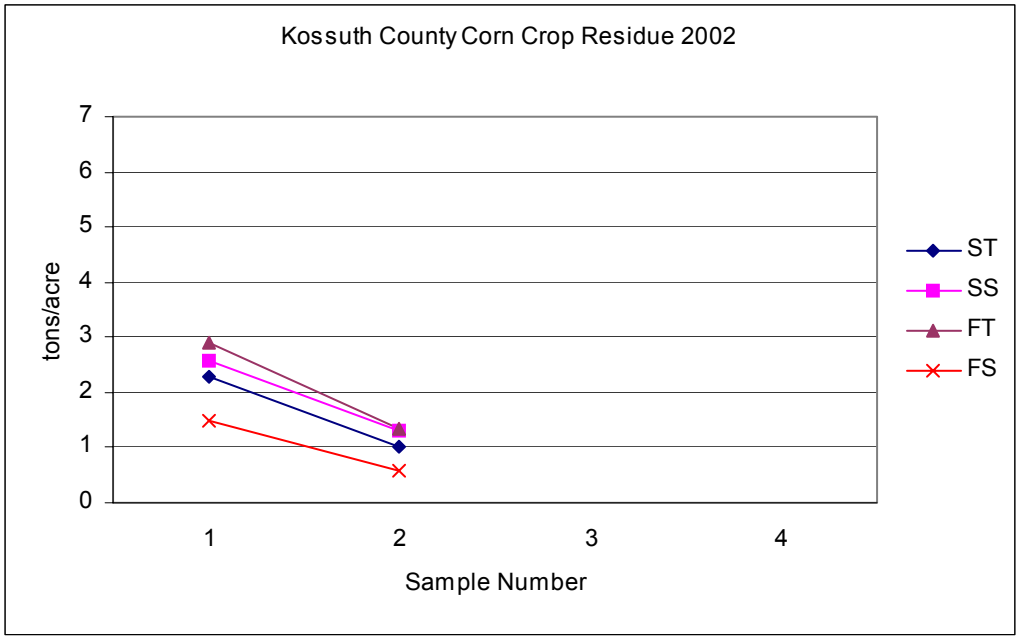


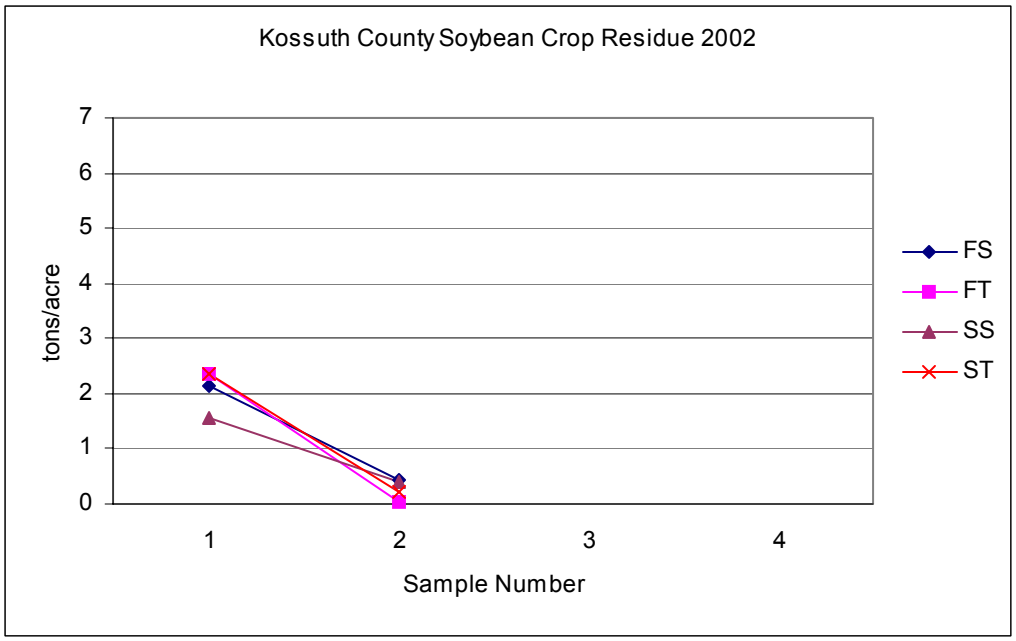
15 Feb 02


Kossuth County Cumulative Growing Degree Days and Precip 2002
Planting Date: 4/25/02
Harvest Date:
deg F
inch
4000
3500
3000
2500
2000
1500
1000
500
0
25
20
15
10
5
0
1
15
29
43
57
71
85
99
113
127
141
155
169
183
197
211
225
239
Day After Planting
GDD
Precip


Kossuth County Corn Analysis 2002
bu/acre
%
225
200
175
150
125
100
75
12
10
8
6
4
2
0
Fall Strip
Fall Till
Spring Strip
Spring Till
Tillage Practice
Yield
Protein
Oil


Kossuth County Soybean Analysis 2002
bu/acre
%
80
70
60
50
40
30
20
10
0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
FS
FT
SS
ST
Yield
Grain Quality
Yield
Protein
Oil
Fiber
Carbo
Sum


Kossuth County Corn Crop Residue 2002
tons/acre
7
6
5
4
3
2
1
0
1
2
3
4
Sample Number
ST
SS
FT
FS



Soybean at the Algona site in Kossuth County on July 12, 2002.

IFLM Project
2002

Soil Boundary
Field Border
Plot Boundary
Drainages

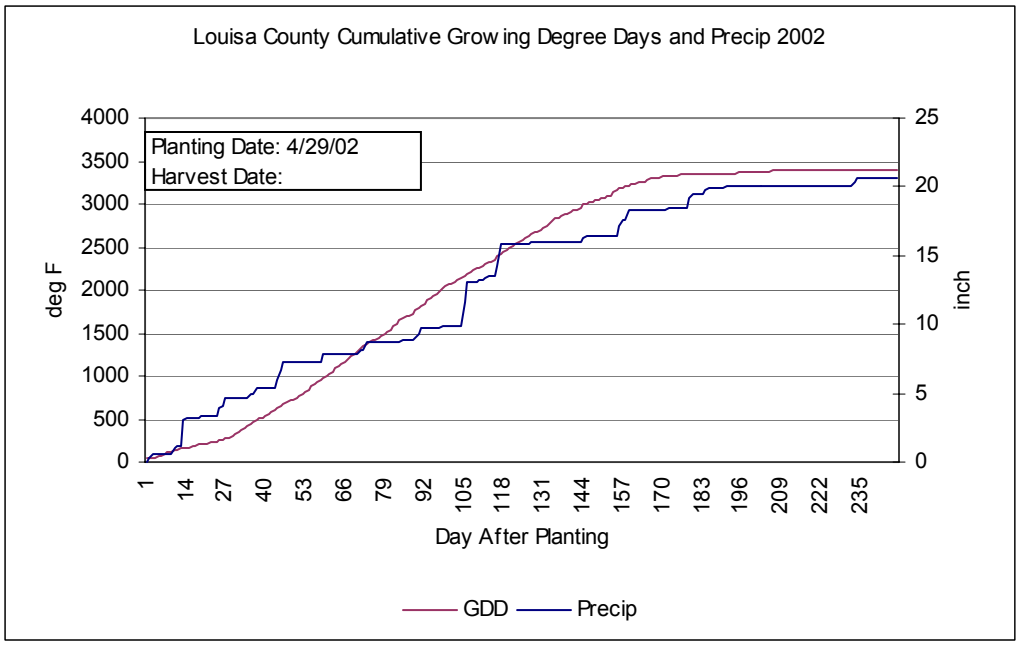
Louisa County: Egli Farm
T74N R5W Section 6
UTM, Zone 15, meters, NAD83

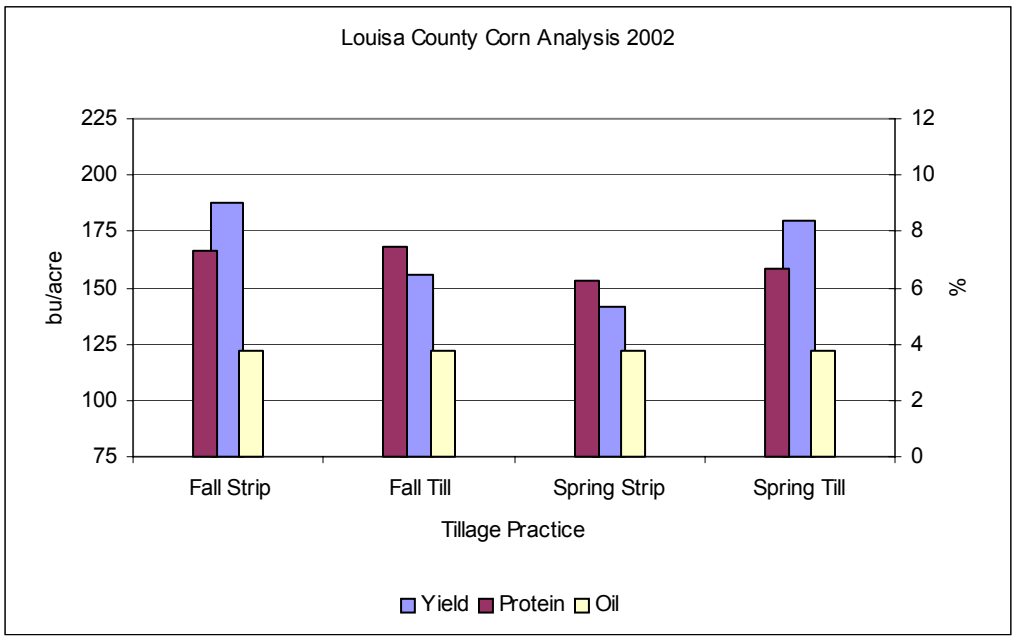
Scale 1:4554

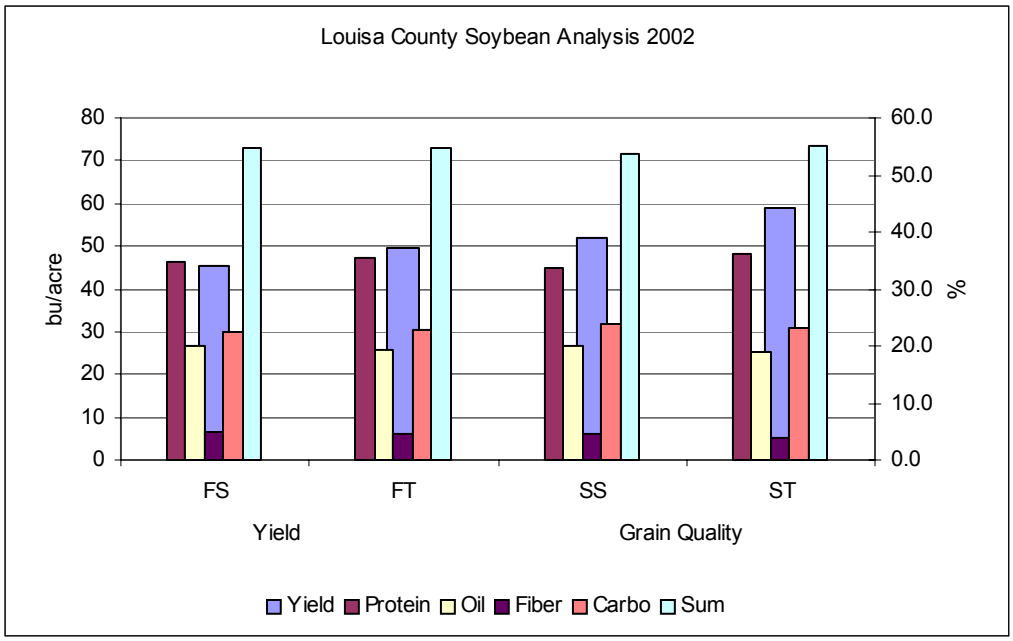
76B: Ladoga silty loam
223D2: Pinda silty clay loam
279: Tama silty clay loam
280: Muscatine silty clay loam
281B: Otley silty clay loam, 2-5% slopes
281C2: Otley silty clay loam, 5-9% slope, moderately eroded
570B: Nira silty clay loam, 2-5% slopes
570C2: Nira silty clay loam, 5-9% slopes, moderate

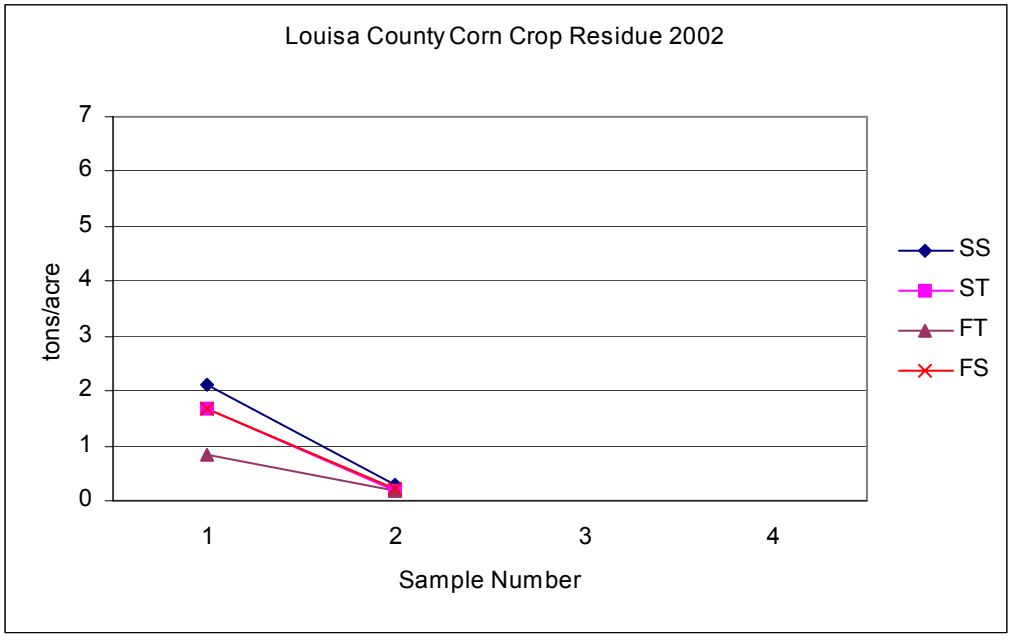
Prepared By: Wolfgang Oesterreich
USDA-ARS
National Soil Tilth Lab
Ames, IA

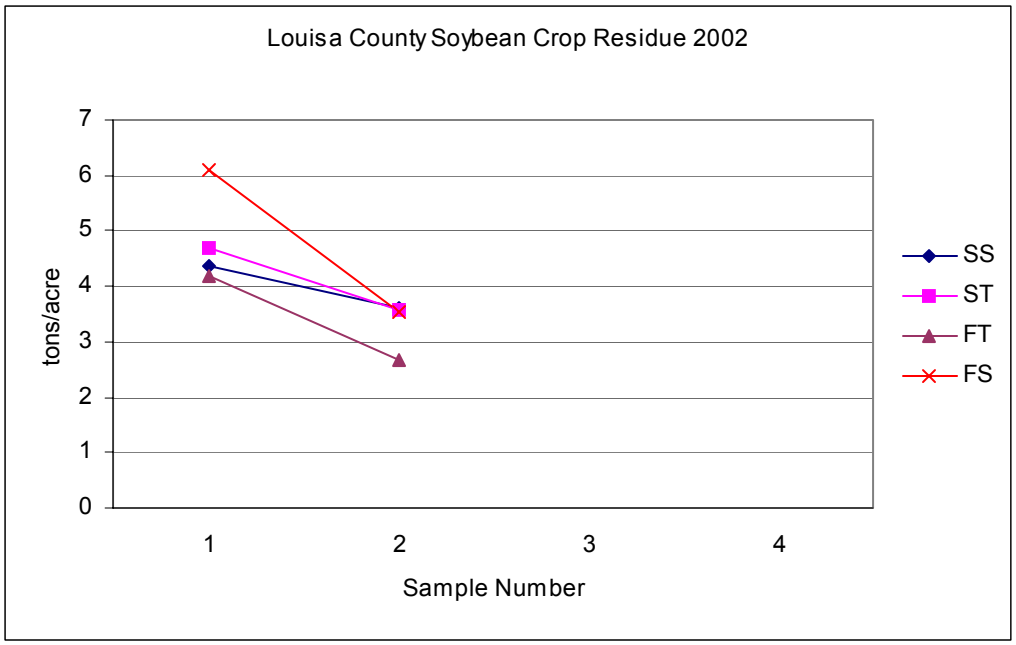
15 Feb 02


Louisa County Cumulative Grow ing Degree Days and Precip 2002
Planting Date: 4/29/02
Harvest Date:
deg F
inch
4000
3500
3000
2500
2000
1500
1000
500
0
25
20
15
10
5
0
1
14
27
40
53
66
79
92
105
118
131
144
157
170
183
196
209
222
235
Day After Planting
GDD
Precip


Louisa County Corn Analysis 2002
bu/acre
%
225
200
175
150
125
100
75
12
10
8
6
4
2
0
Fall Strip
Fall Till
Spring Strip
Spring Till
Tillage Practice
Yield
Protein
Oil


Louisa County Soybean Analysis 2002
bu/acre
%
80
70
60
50
40
30
20
10
0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
FS
FT
SS
ST
Yield
Grain Quality
Yield
Protein
Oil
Fiber
Carbo
Sum


Louisa County Corn Crop Residue 2002
tons/acre
7
6
5
4
3
2
1
0
1
2
3
4
Sample Number
SS
ST
FT
FS


Louisa County Soybean Crop Residue 2002
tons/acre
0
1
2
3
4
5
6
7
1
2
3
4
Sample Number
SS
ST
FT
FS

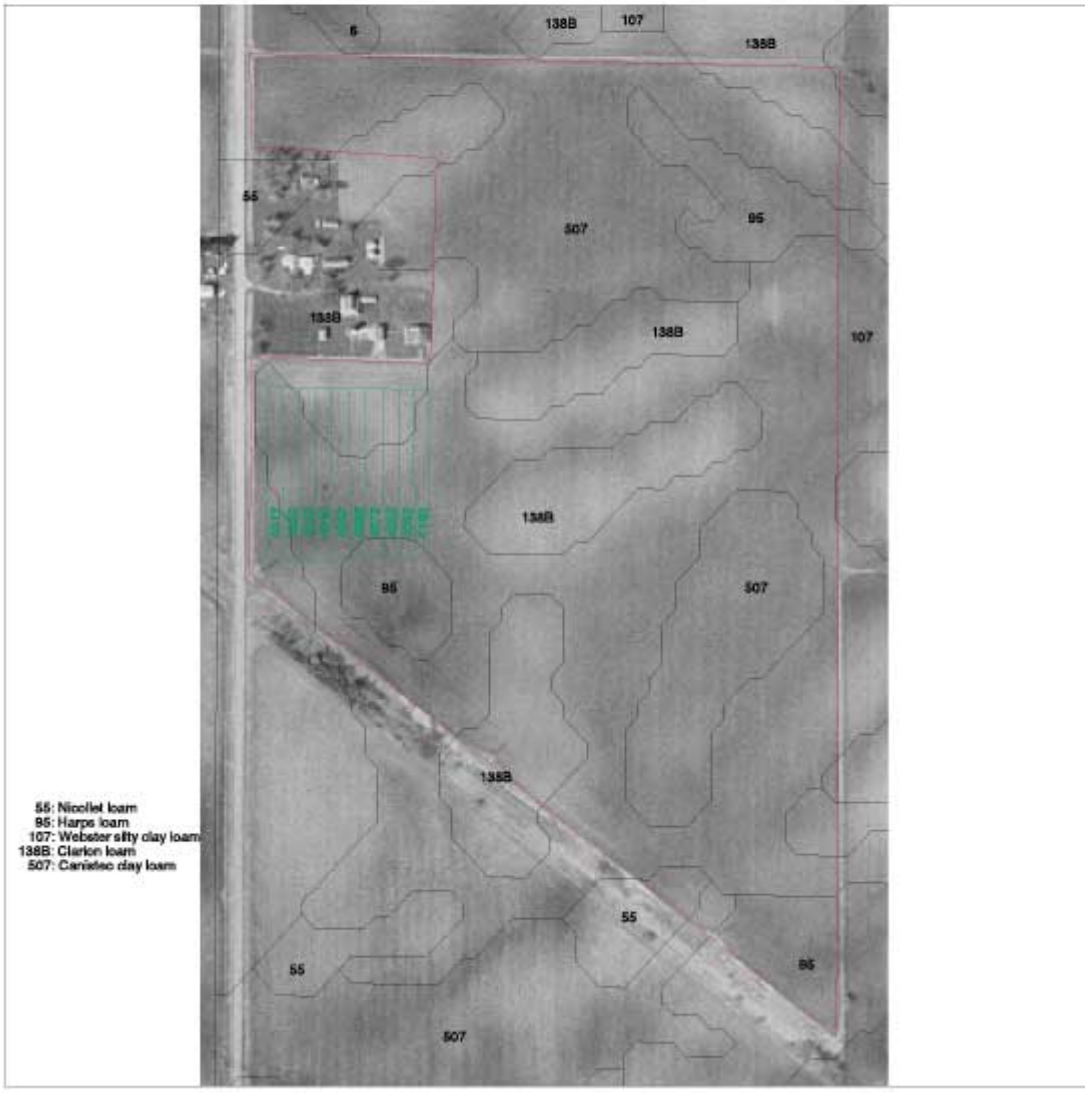
IFLM Project
2002

Soil Boundary
Field Border
Plot Boundary
Drainages

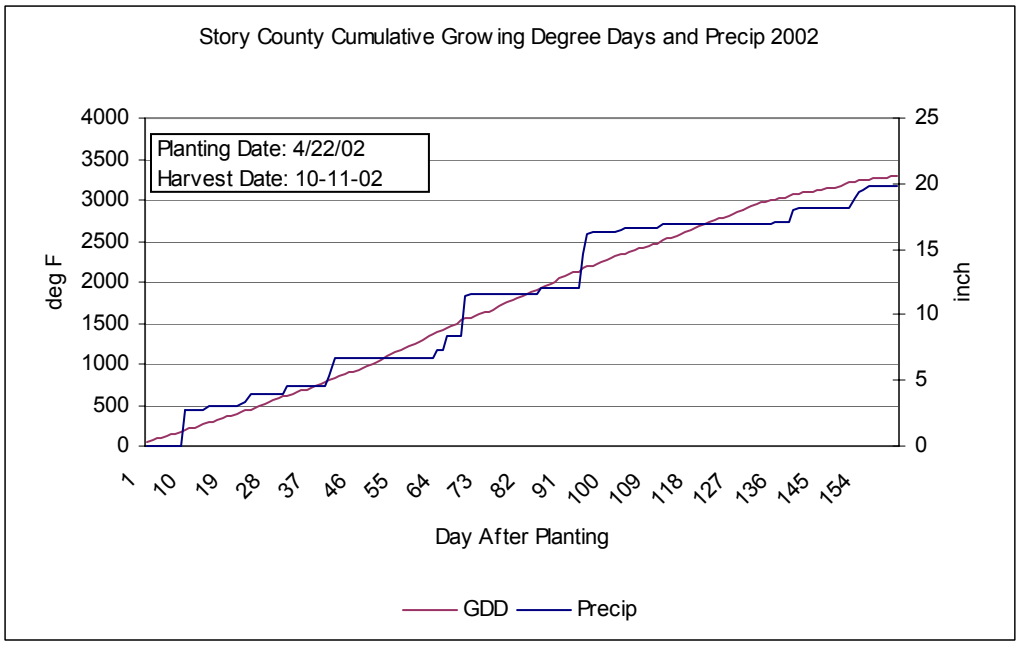
Story County: Kaltenheuser Farm
T83N R24W Section 30
UTM, Zone 15, meters, NAD83

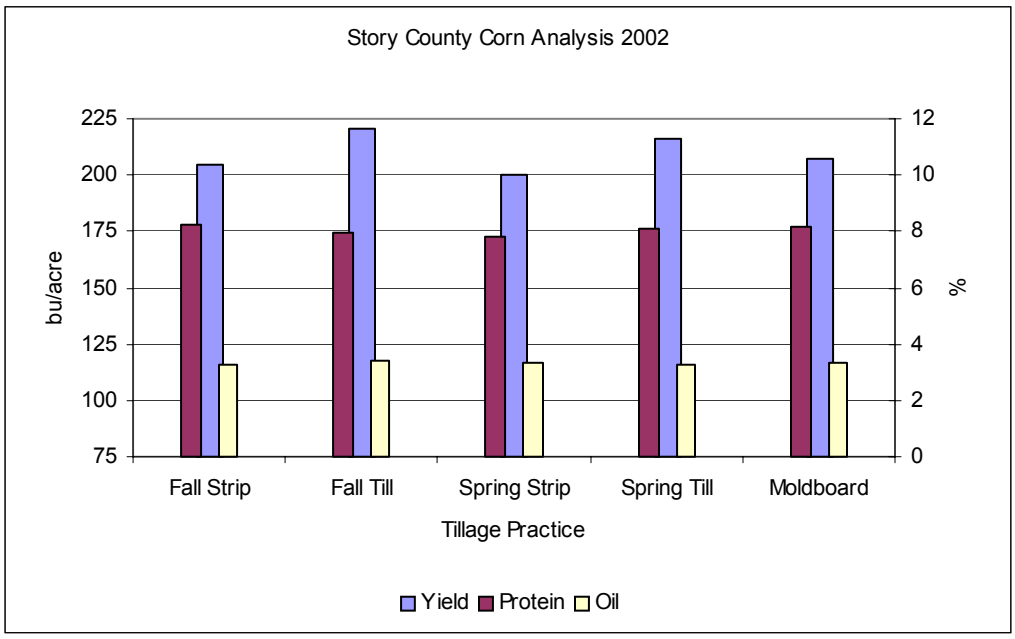
Scale 1:4468

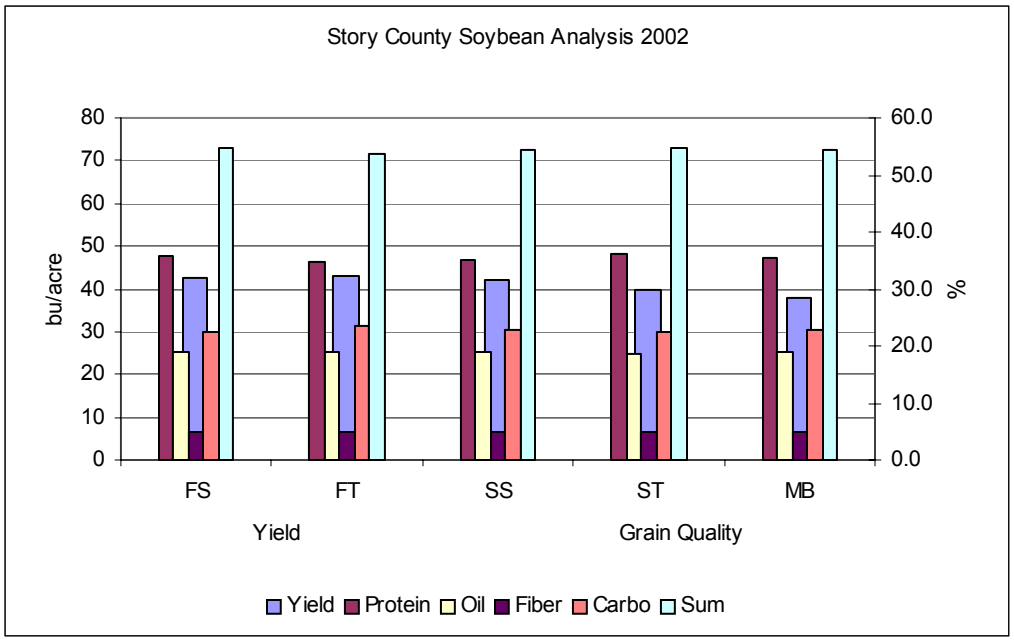
Prepared By: Wolfgang Oesterreich
USDA-ARS
National Soil Tilth Lab
Ames, IA

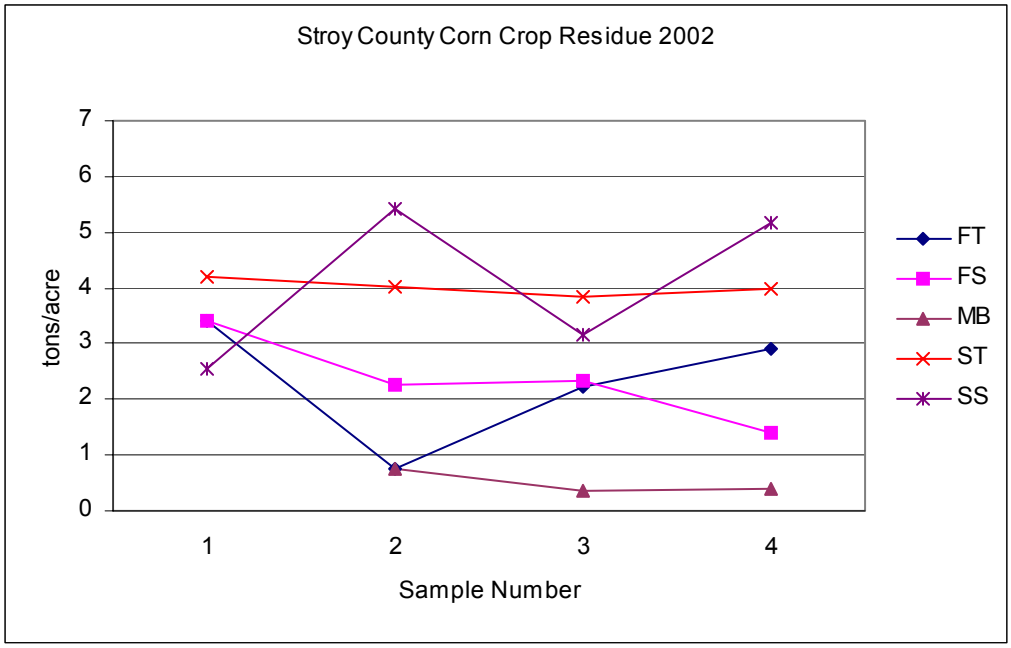


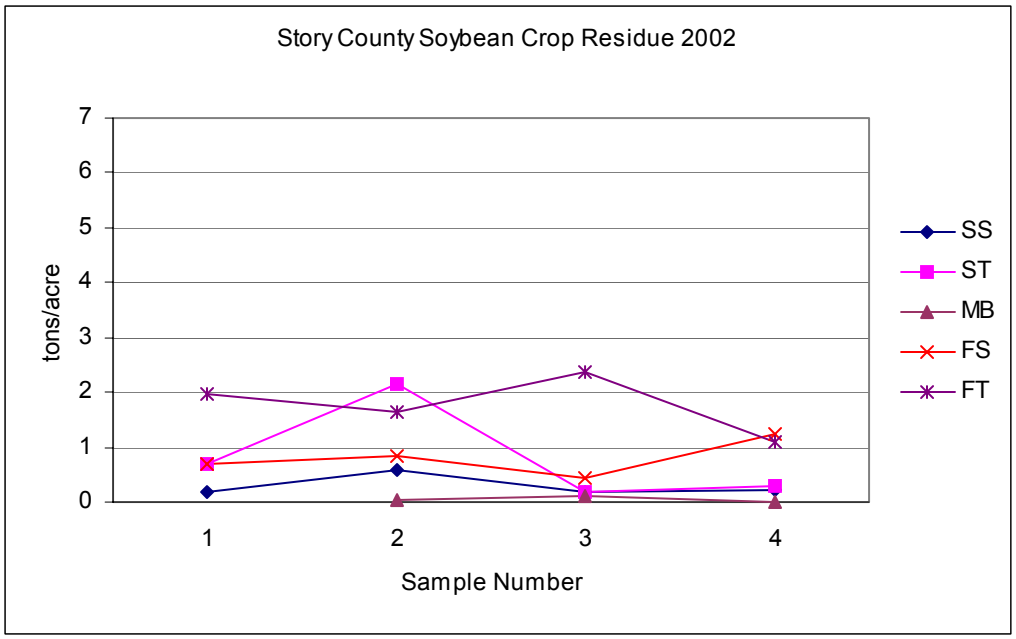
15 Feb 02


Story County Cumulative Growing Degree Days and Precip 2002
Planting Date: 4/22/02
Harvest Date: 10-11-02
deg F
inch
4000
3500
3000
2500
2000
1500
1000
500
0
25
20
15
10
5
0
1
10
19
28
37
46
55
64
73
82
91
100
109
118
127
136
145
154
Day After Planting
GDD
Precip


Story County Corn Analysis 2002
bu/acre
%
225
200
175
150
125
100
75
12
10
8
6
4
2
0
Fall Strip
Fall Till
Spring Strip
Spring Till
Moldboard
Tillage Practice
Yield
Protein
Oil


Story County Soybean Analysis 2002
bu/acre
%
80
70
60
50
40
30
20
10
0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
FS
FT
SS
ST
MB
Yield
Grain Quality
Yield
Protein
Oil
Fiber
Carbo
Sum


Stroy County Corn Crop Residue 2002
tons/acre
7
6
5
4
3
2
1
0
1
2
3
4
Sample Number
FT
FS
MB
ST
SS


Story County Soybean Crop Residue 2002
tons/acre
7
6
5
4
3
2
1
0
1
2
3
4
Sample Number
SS
ST
MB
FS
FT

IFLM Project
2002

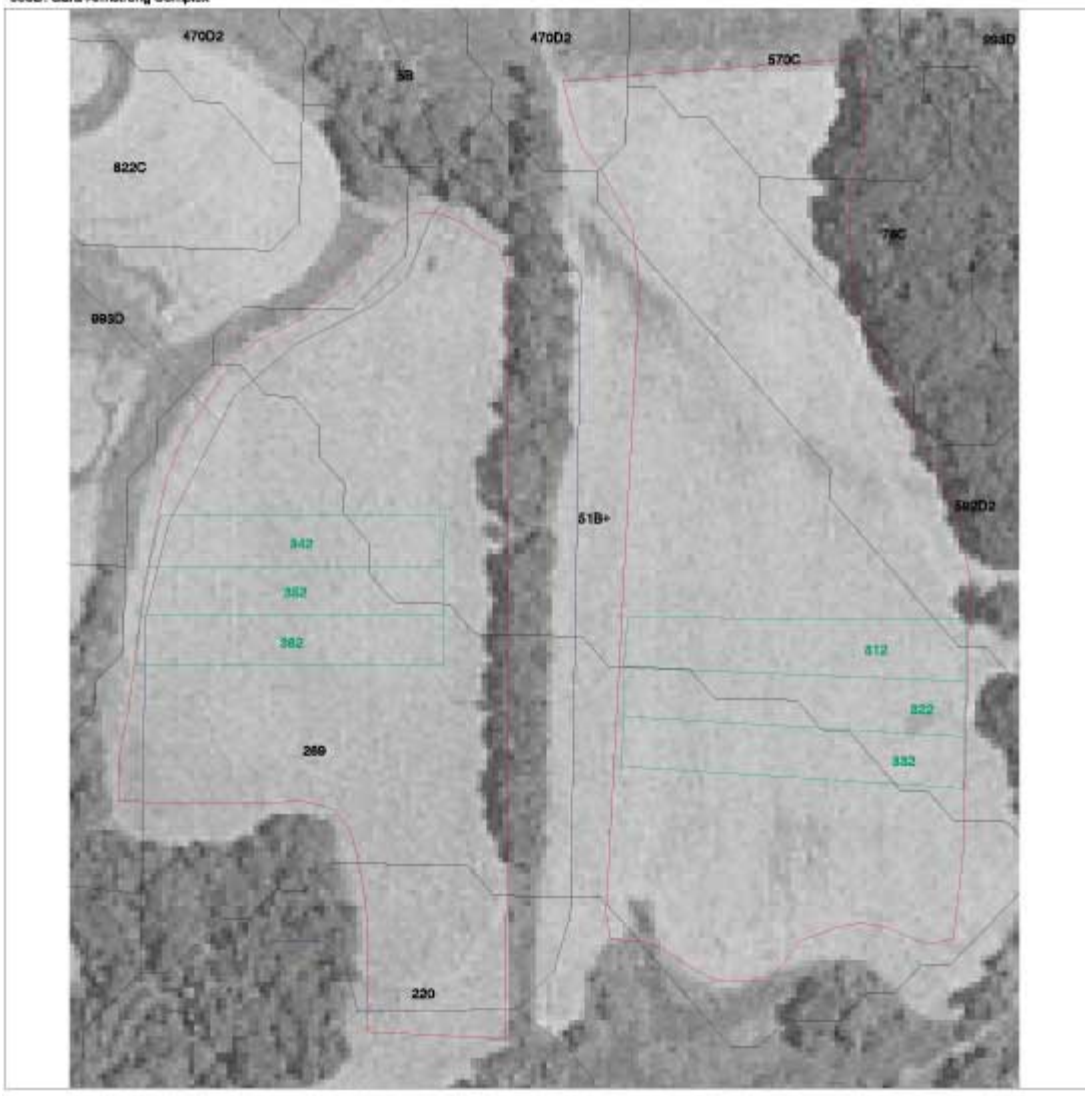
Soil Boundary
Field Border
Plot Boundary
Drainages

5B: Colo-Ackmore Complex
51B+: Vesser silt loam, overwash
78C: Ladoga silt loam
220: Nodaway silt loam
269: Humeston silty clay loam
470D2: Lamoni-Shelby Complex
570C: Nira silty clay loam
592D2: Myatic silt loam
822C: Lamoni silty clay loam
993D: Gara-Armstrong Complex

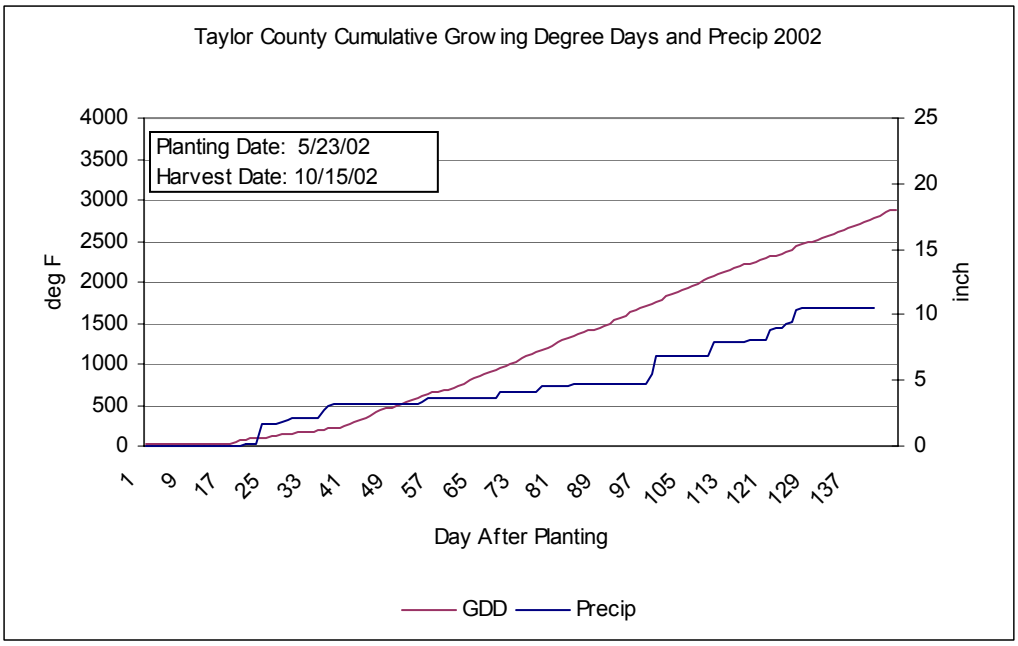
Taylor County: Duke Farm
T68N R33W Section 28
UTM, Zone 15, meters, NAD83

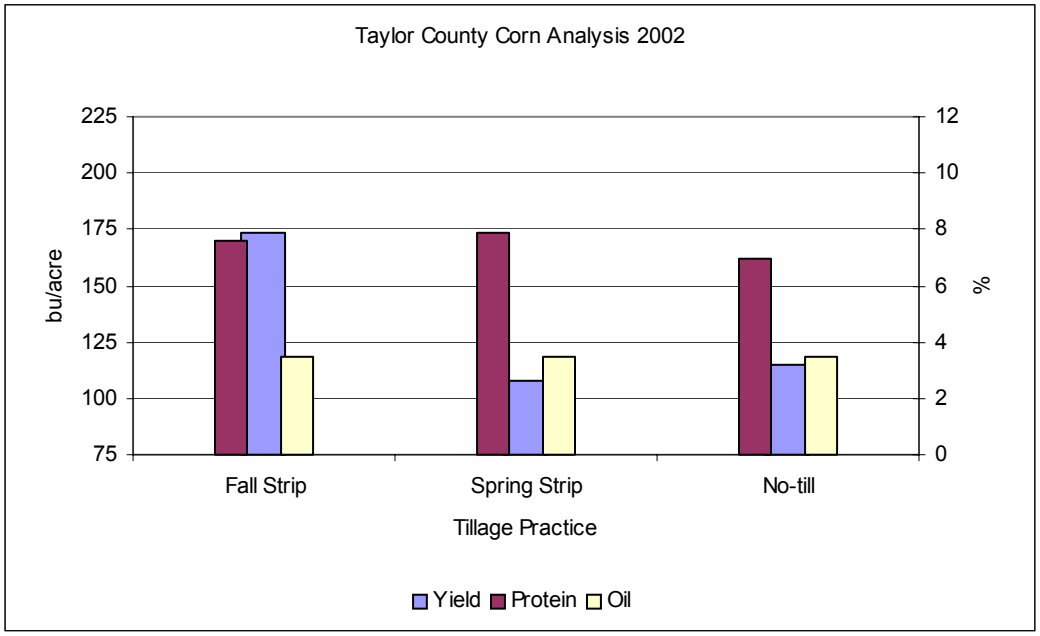
Scale 1:2092

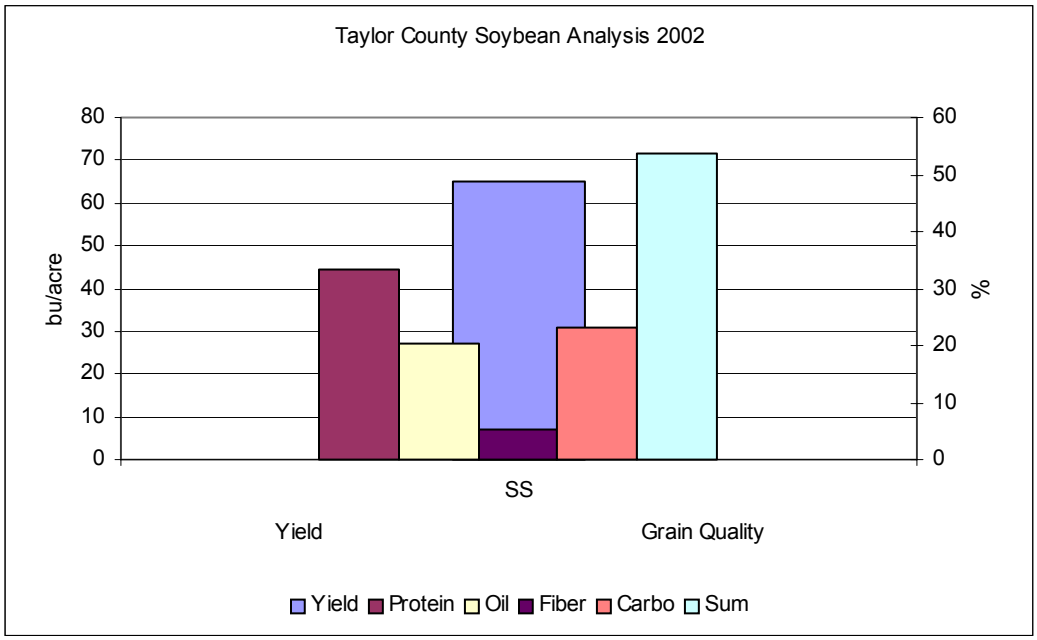
Prepared By: Wolfgang Oesterreich
USDA-ARS
National Soil Tilth Lab
Ames, IA

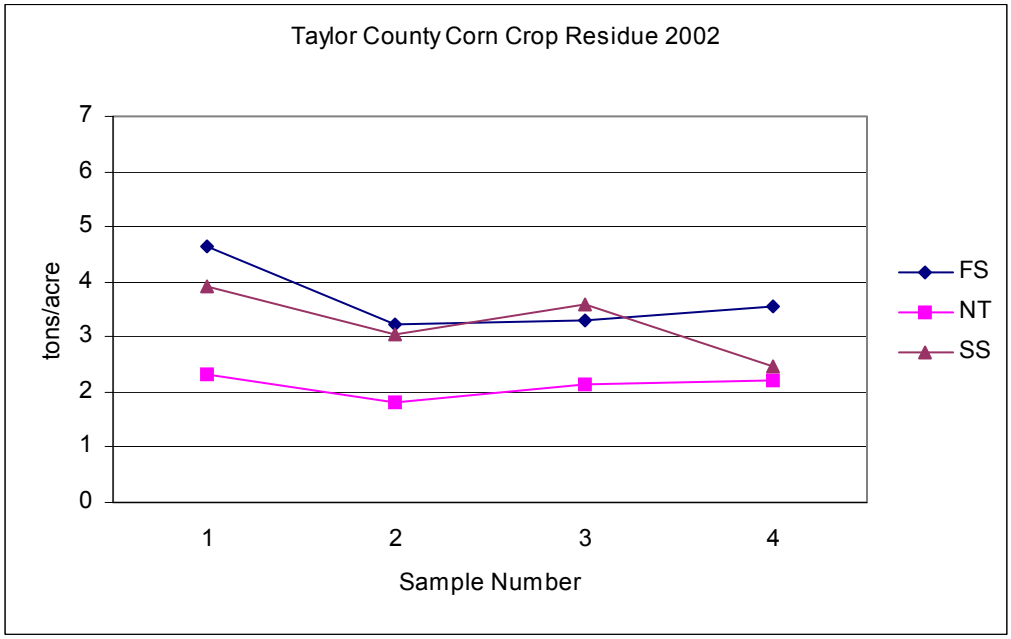


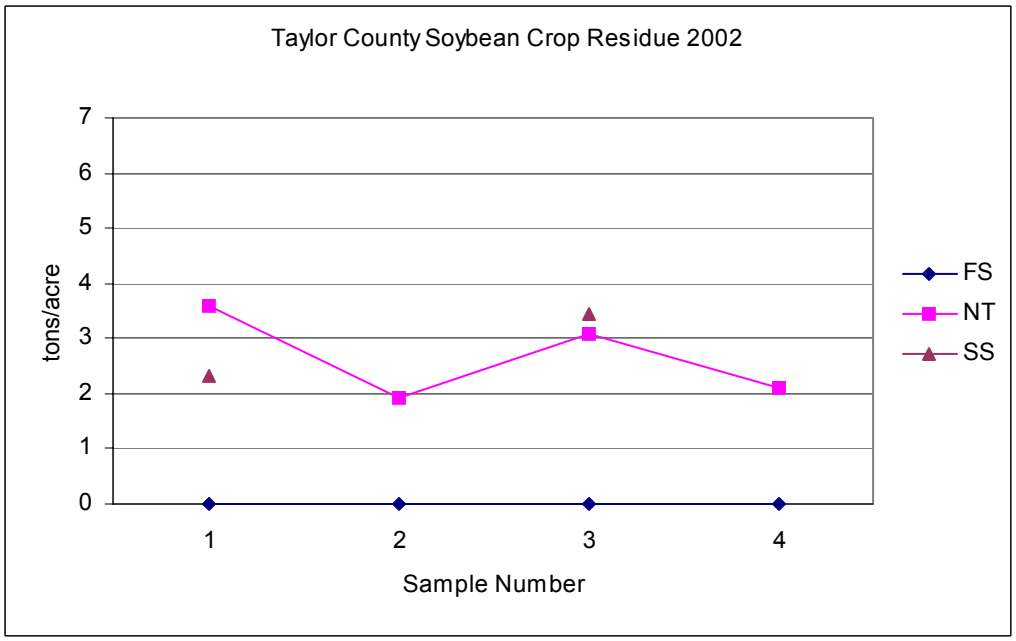
15 Feb 02


Taylor County Cumulative Growing Degree Days and Precip 2002
Planting Date: 5/23/02
Harvest Date: 10/15/02
deg F
inch
4000
3500
3000
2500
2000
1500
1000
500
0
25
20
15
10
5
0
1
9
17
25
33
41
49
57
65
73
81
89
97
105
113
121
129
137
Day After Planting
GDD
Precip


Taylor County Corn Analysis 2002
bu/acre
%
225
200
175
150
125
100
75
12
10
8
6
4
2
0
Fall Strip
Spring Strip
No-till
Tillage Practice
Yield
Protein
Oil

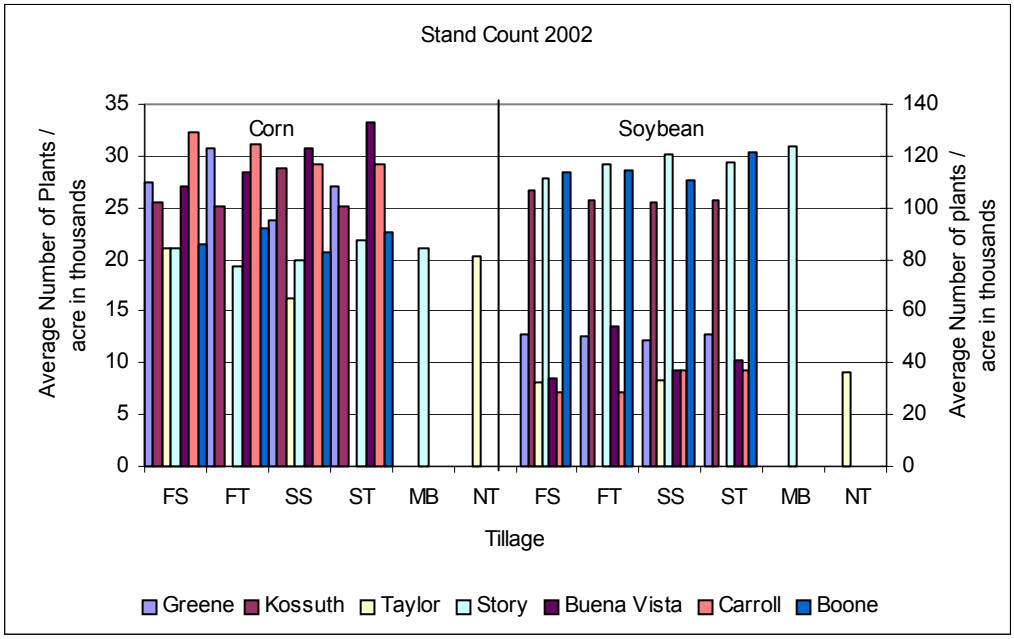

Taylor County Soybean Analysis 2002
bu/acre
%
80
70
60
50
40
30
20
10
0
60
50
40
30
20
10
0
SS
Yield
Grain Quality
Yield
Protein
Oil
Fiber
Carbo
Sum

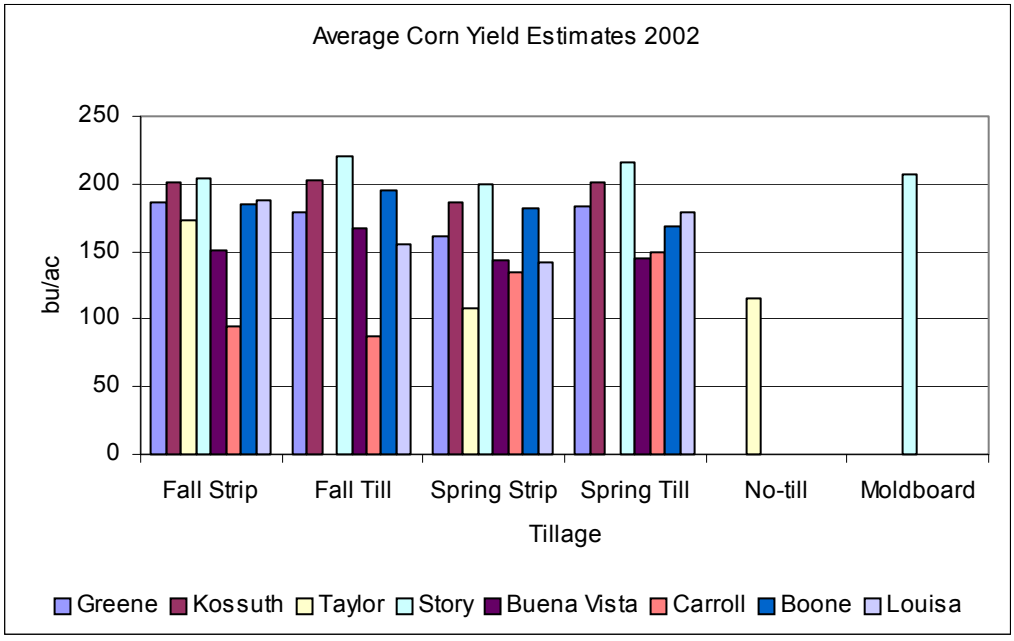

Taylor County Corn Crop Residue 2002
tons/acre
7
6
5
4
3
2
1
0
1
2
3
4
Sample Number
FS
NT
SS

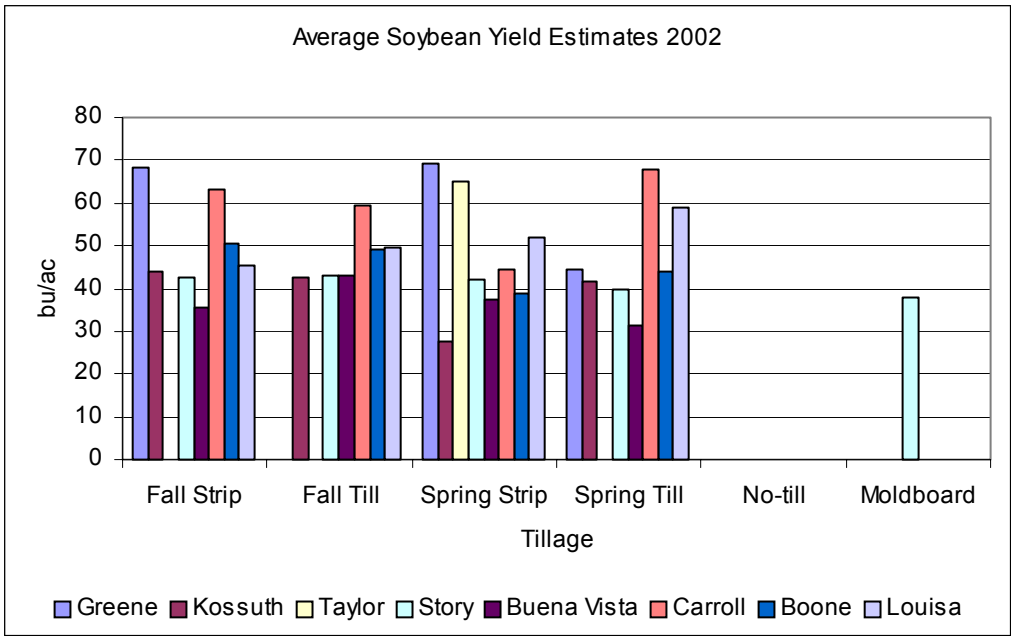


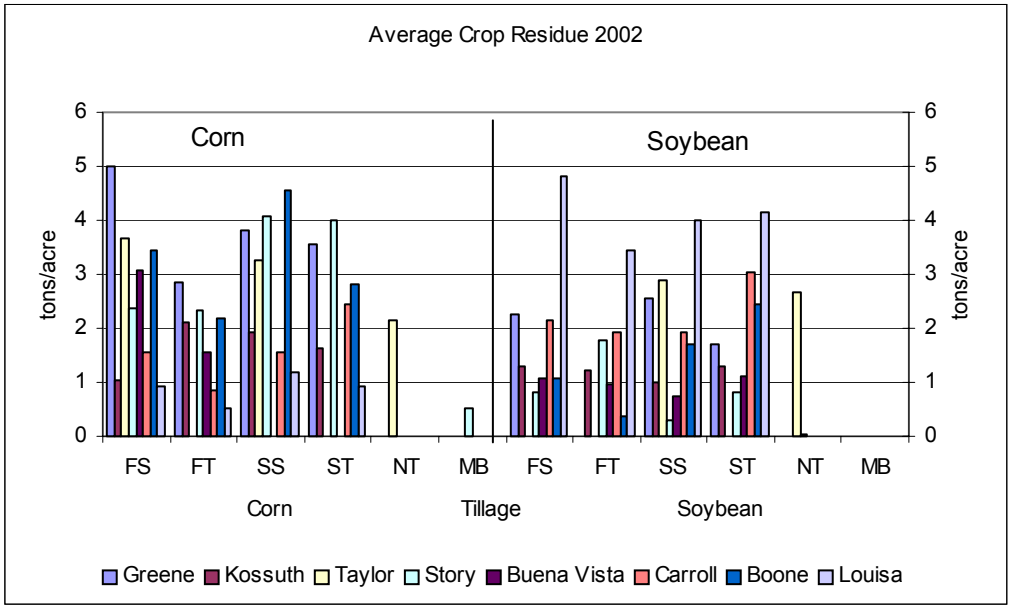
Results – Summary for All Sites

Following are several summary figures for stand count, corn yield, soybean yield, and residue mass. These data are preliminary and statistical analyses have yet to be completed to determine whether statistically significant differences occur.




Average Corn Yield Estimates 2002
250
200
150
100
50
0
bu/ac
Fall Strip
Fall Till
Spring Strip
Spring Till
No-till
Moldboard
Tillage
Greene
Kossuth
Taylor
Story
Buena Vista
Carroll
Boone
Louisa


Average Soybean Yield Estimates 2002
80
70
60
50
40
30
20
10
0
bu/ac
Fall Strip
Fall Till
Spring Strip
Spring Till
No-till
Moldboard
Tillage
Greene
Kossuth
Taylor
Story
Buena Vista
Carroll
Boone
Louisa



Average corn yields were 177.8, 173.1, 172.5, and 157.0 bushels/acre for the ST, FS, FT, and SS systems, respectively. Yields across all sites varied by approximately 50 bushels/acre with the exception of low yields for FS and FT at the Carroll site and SS at the Taylor site. These low-yielding treatments can be explained by site conditions at planting or early in the growing season. Although the Story site had some of the lowest stand counts, the highest corn yields for each tillage system were observed at this site. Average soybean yields were 50.0, 47.9, 47.1, and 46.8 bushels/acre for the FS, FT, SS, and ST systems, respectively. Highest soybean yields for individual tillage systems were observed at the Greene and Carroll sites. Soybean stand counts were > 100,000 for the Kossuth, Story, and Boone sites with the remaining sites having stand counts ~ 40,000. Residue mass samples were collected after fall field operations, thus the generally greater mass of residue remaining for the SS and ST treatments.

Outreach

This is the first year of the project and much of the information is in preliminary form. A series of Field Days were held to increase the visibility of the IFLM Program and this demonstration project and to begin the survey process for producers to determine their reaction to different tillage systems and their expectations for the ideal tillage system. The dates and locations for the Field Days were: Carroll County-August 19; Kossuth County-August 21; Buena Vista County-August 27; Taylor County-August 27; Louisa County-August 29; Greene County-September 5; and Boone and Story County-September 6. In addition to growers, representatives from local agrichemical and agricultural consulting firms were in attendance and participated in discussions of project goals and findings.

To increase the interaction among the partners and the potential impact of this project an evaluation of the 2002 growing season will be held on February 25, 2003 at the National Soil Tilth Laboratory. The purpose of this meeting is to review the progress and determine other measures of tillage responses that can further increase the value of this study.

We have formed partnerships with NRCS and the Conservation Technology Information Center (CTIC) in this project along with a number of consultants in Iowa. All of these parties have an interest in improved tillage systems and are following the project with interest. During 2003 we expect that these groups will begin to utilize the sites and data as part of their efforts.

A web page (Tillage Demo) within the NSTL web site has also been created for the project. In addition to project background, maps of soils, topography, and plot layouts are available. Data summaries from the 2002 growing season are currently being prepared. In 2003, the web site will be used by the FFA groups to enter the data they collect into the project database.

Additional Partners

Local FFA chapters are participants in this demonstration project and involved in the data collection process. They are using this as part of their educational programs and will be using the data as part of the curriculum during the school year. We feel this will help their understanding of soil management and tillage operations. CTIC is following these demonstrations as part of their effort to promote the Core4 program throughout the nation. NRCS is interested in using these sites to collect data on soil quality changes under different tillage systems and participating in data collection to determine the erosion rates under the different tillage systems in 2003.

The National Soil Tilth Laboratory has a major commitment to this project to help quantify the changes in soil properties (water, temperature and carbon) and the interaction with genetic material. These data will help guide producers about the potential interactions of soil management and hybrid or variety selection. These groups will help promote the concept of improved tillage operations and the potential benefits on crop production efficiency and environmental quality.